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REGISTER

OF THE

BALTIMORE POLYTECHNIC

INSTITUTE.

1904-1905.

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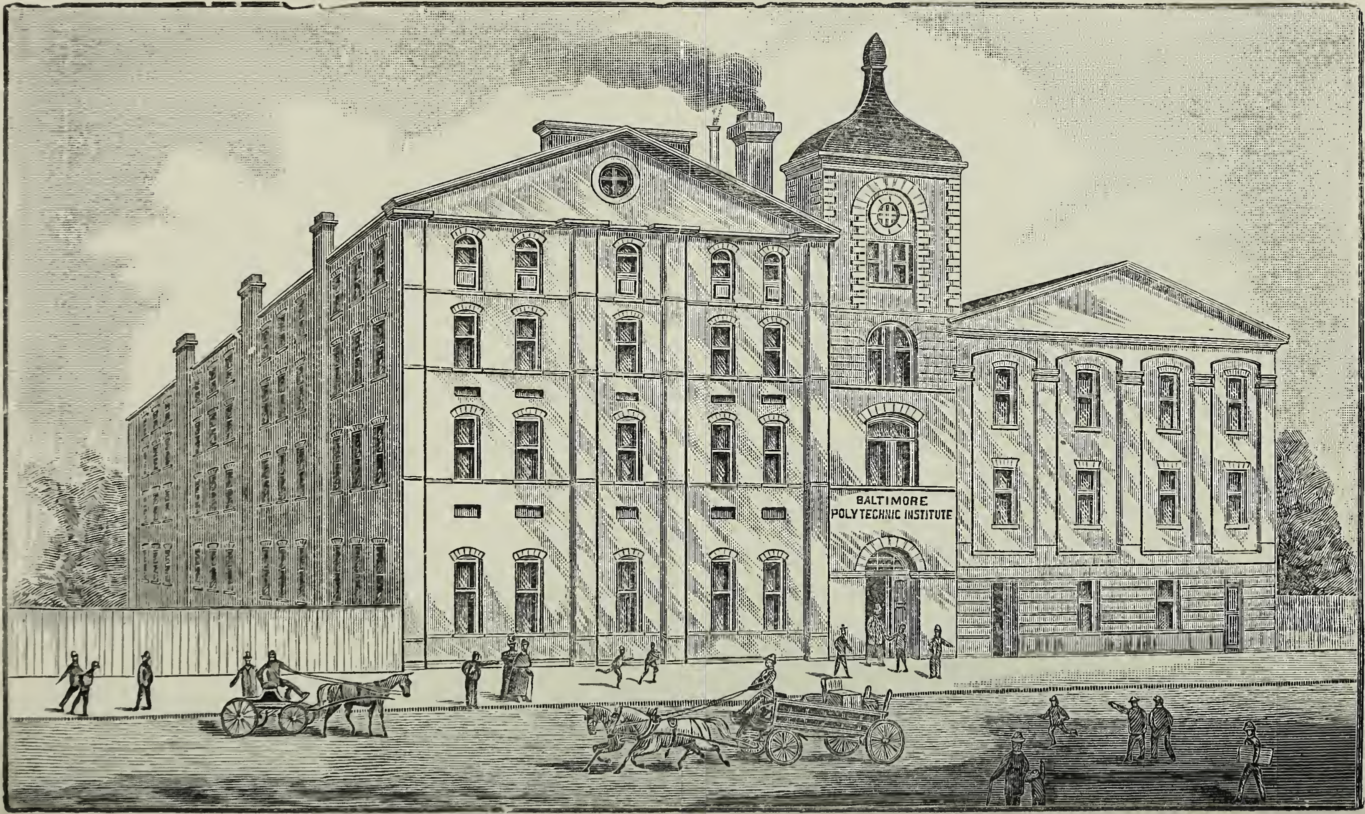

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ANNUAL REGISTER

OF THE

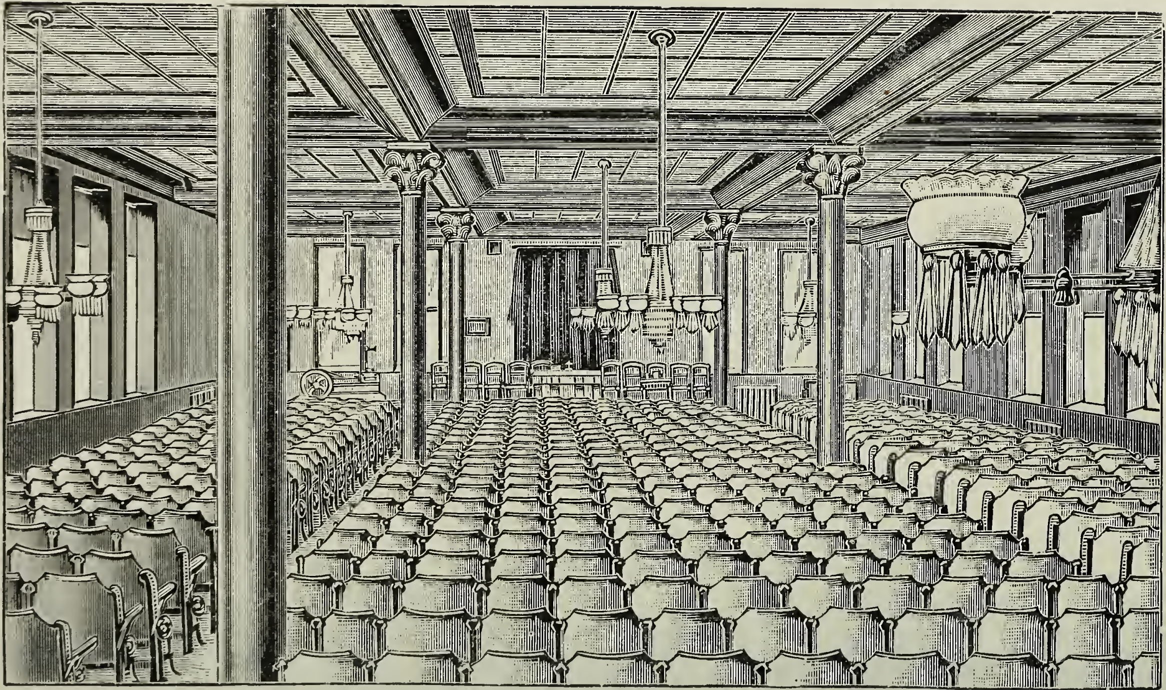
Baltimore Polytechnic Institute

311-331 COURTLAND STREET.

TWENTIETH ACADEMIC YEAR,

1904-1905.

Pearre E. Crowl Co., Printers
Baltimore, Md.
1905.



THE ASSEMBLY ROOM.

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Baltimore Polytechnic Institute.

HISTORICAL SKETCH.

The Baltimore Polytechnic Institute, the second manual training school established in the United States as part of a public school system, is one of the several educational institutions of the secondary grade maintained by the city of Baltimore.

Although it is believed that tentative efforts to engraft manual training upon the city's school system were made as early as 1873 or '74, yet the action which led to the establishment of this school was not taken until April, 1883. At a meeting of the Board of Commissioners of Public Schools, held on the 24th of that month, Mr. Joshua Plaskitt, Commissioner for the Ninth Ward, offered a resolution for the appointment of a committee "to consider . . . . the advisability of establishing a school or schools for manual training." The resolution was adopted, and the committee thus appointed recommended the establishment of a school "for manual education." The necessary enabling ordinances and enactments having been passed by the City Council of Baltimore and the General Assembly of Maryland, the school was organized and opened on February 26, 1884, under the name "Baltimore Manual Training School," with Dr. Richard Grady as Director.

In January, 1886, the faculty was reorganized, Lieut. John D. Ford, an officer of the Engineer Corps of the United States Navy, who had been detailed for duty at the school, becoming Principal.

From the opening of the school applicants for admission had been required to pass through the eighth grammar school grade, or to show satisfactory evidence of having had equal instruction; but in September, 1888, it was decided to admit pupils of the sixth, seventh, and eighth grammar grades. This action opened the school to so large a number of young boys that increased accommodations became imperative; and in June, 1890, the new building, devoted to the academic studies and drawing, was finished and occupied.

Lieut. Ford was recalled to the naval service in June, 1890, and was succeeded as Principal by John W. Saville, a retired member of the Engineer Corps of the Navy.

In May, 1893, the name of the school was changed to "Baltimore Polytechnic Institute," and the titles of Principal and Vice-Principal to President and Vice-President, respectively.

Mr. Saville resigned in August, 1899, and was succeeded as President by Lieut. William R. King, Engineer Corps, U. S. N., the present head of the school.

The new charter of Baltimore went into effect on March 1, 1900, and under one of its provisions it devolved upon the Mayor, Hon. Thomas G. Hayes, to appoint ,as the head of the Department of Education, a Board of School Commissioners composed of nine persons, to serve without pay, and to be chosen from among those citizens he deemed "most capable of promoting the interests of public education, by reason of their intelligence, character, education, or business qualifications." The names of the distinguished citizens so chosen will be found on page 14.

Another provision of the Charter requires that, "in order to secure the continuance of local interest in, and oversight of the public schools, there shall be appointed by said Board of School Commissioners such number of unpaid School Visitors as may be found requisite." In pursuance of this provision there was appointed as a Board of Visitors to this institution, a group of gentlemen, some of whom are recognized in technical circles throughout the country as being at the head of their respective professions.

The members of the Board of Visitors had no sooner acquainted themselves with the general conditions prevailing in the school—the age and attainments of the pupils of the lower grades, the character of the work done, and the scope of the curriculum—than they submitted to the Board of School Commissioners a very comprehensive and exhaustive report discussing the condition, needs, and aims of the school, and recommending certain changes in the requirements for admission, and in the curriculum. The partial adoption of this report in September, 1900, excluded grammar school pupils from the Institute, thus making the standard for admission the same as that for the City College.

In April, 1901, a further consideration of the report of the Board of Visitors led to the practical addition of one year to the course by permitting graduates to remain for a year of postgraduate work; and in May, 1902, the length of the course was, by action of the Board, set at four years for pupils entering on and after September 15, 1902.

It was further provided that pupils leaving the Institute before the completion of the course should receive certificates of the work done by them up to the time of their withdrawal.

By operation of the new Charter the titles of President and Vice-President were changed, in 1900, to Principal and Vice-Principal.

Record of the Faculty and Staff.

FROM THE ORIGIN OF THE INSTITUTE TO DECEMBER 31, 1904.

The school was organized on February 26, 1884, under the name "Baltimore Manual Training School;" this name was changed in May, 1893, to "Baltimore Polytechnic Institute."

Richard Grady, M.D., D.D.S., Director, February 26, 1884. Services terminated January 11, 1886.

John D. Ford, P. A. Eng., U. S. N., Instructor in Drawing and Steam Engineering, February 26, 1884. Principal, January 11, 1886. Recalled to Naval Service, June 30, 1890.

William Dugent, Instructor in Wood Work, February 26, 1884. Transferred to Pattern Shop, January 11, 1886, and was in charge of that department until September 17, 1900.

J. H. W. Onion, Instructor in Pattern Department, March 1, 1884. Services terminated June 30, 1886.

A. Newton Ebaugh, First Assistant in Academic Department, January 11, 1886. Vice-President, May, 1893. Transferred to Baltimore City College, June 30, 1896, as Professor of History and Political Economy.

C. F. Friese, Instructor in Metal Department, September 1, 1886. Resigned to accept position in Chicago Manual Training School, June 30, 1891.

W. H. Hall, B.C.C., '85, Assistant Instructor in Physics and Chemistry, September 23, 1886. Instructor in Academic Department, June 7, 1898. Head of Department of Physics and Chemistry, September 13, 1899. Head of the Department of Science, June 21, 1901.

William G. Richardson, Assistant Instructor in Machine Department, February, 1887. Instructor in Machine Work and Engineering Materials, September 13, 1899.

Andrew J. Pietsch, Assistant Instructor in Academic Department, September 1, 1887. Transferred to be Principal of Male Grammar School No. 4, September, 1890.

J. C. McSherry, Assistant Instructor in Academic Department, September, 1887. Resigned, April, 1888.

Richard Piez, B.M.T.S., '87, Instructor in Mechanical Drawing, September, 1887. Resigned, September, 1891.

Lawrence Griffith, Assistant to the Principal and Instructor in Free-hand Drawing, September, 1887. Resigned, June, 1890.

John L. Yater, Assistant Instructor in Academic Department, September, 1888. Transferred to be Principal of Annex School No. 14, January, 1899.

Flavius J. Pennington, B.M.T.S., '87, Assistant Instructor in Wood Department, September, 1888. Resigned, April 1, 1889.

David G. Butterfield, Assistant Instructor in Academic Department, September 11, 1888. Transferred to be First Assistant in Male Grammar School No. 20, March 19, 1889.

Thomas G. Ford, B.M.T.S., '88, Assistant Instructor in Wood Department, October, 1888. Assistant Instructor in Carving and Pattern-making, September, 1897. Instructor in Pattern-making and Wood-turning, September 17, 1900, and, in addition, Assistant in Mechanical Drawing, September, 1902.

John T. Robinson, Assistant Instructor in Sheet Metal Department, October, 1888. Resigned to become instructor in Sheet Metal Work at the Brooklyn Polytechnic Institute, Brooklyn, N. Y., June 30, 1894.

J. Ward Willson, M.D., B.C.C., '61, Assistant Instructor in Academic Department, March 21, 1888. Instructor in Academic Department, September, 1898. Instructor in History, Physiology, and German, September 16, 1901. Instructor in German, English and Science, September, 1902.

George M. Gaither, B.M.T.S., '88, Assistant Instructor in Wood Department, April 1, 1889. Instructor in Carpentry and Carving, September 17, 1900.

Richard H. Uhrbrock, B.C.C., '86, Ph.B., I.W.U., '97, Assistant Instructor in Academic Department, May 15, 1889. Vice-President and Instructor in Mathematics, September, 1896. Head of Department of Mathematics, September 13, 1899. Vice-Principal, June 21, 1901.

John W. Saville, P. A. Eng., U. S. N. (retired), Principal and Instructor in Steam Engineering, September, 1890. President and Instructor in Steam Engineering, May, 1893. Resigned, August 31, 1899.

Edward S. Kines, B.C.C., '90, Assistant Instructor in Academic Department, September, 1890. Resigned, October 1, 1894.

J. Henry Laessig, Assistant to Principal and Instructor in Mechanical Drawing, September, 1890. Resigned, June 30, 1893.

Eason Lewis, Lieut. U. S. A., Instructor in Military Drill and Assistant Instructor in Academic Department, November, 1890. Recalled to U. S. Army, April, 1891.

Albert McClean, Instructor in Forge Work, September, 1891. Resigned, January, 1898.

Warren S. Seipp, B.M.T.S., '91, Instructor in Free-hand Drawing, September, 1891. Instructor in Free-hand Drawing and Carpentry, November, 1901. Instructor, Manual Training Centre No. 1, June, 1902. Instructor in Drawing, Carpentry, and Sheet Metal Work, September, 1903.

B. Wheeler Sweany, Instructor in Mechanical Drawing, September, 1892. Transferred to Baltimore City College as Professor of Drawing, October 1, 1897.

Joseph F. McBee, Assistant Instructor in Academic Department, September, 1893. Transferred to be Principal of Annex School No. 14, June, 1894. Re-transferred to the Baltimore Polytechnic Institute as Assistant Instructor in Academic Department, January, 1899. Dismissed, May, 1899.

Nathaniel D. D. Sollers, Assistant Instructor in Academic Department, September, 1893. Resigned, June, 1894.

F. D. J. Kaessmann, Assistant Instructor in Academic Department, September, 1893, until September, 1901.

William A. Jones, Assistant Instructor in Sheet Metal Department, September, 1894. Instructor in Sheet Metal Department, September, 1898. Instructor in Forge and Sheet Metal Work, September 17, 1900.

Samuel M. North, B.C.C., '87, Assistant Instructor in Academic Department, September, 1894. Instructor in Academic Department, September, 1898. Head of Department of English, September 13, 1899. Head of Department of English, including History and Language, June 21, 1901.

Joseph C. O'Connor, Assistant Instructor in Carpentry, September, 1894. Resigned, June 30, 1897.

Henry Sanders, Instructor in Sheet Metal Department, September, 1894. Resigned, November 30, 1894.

William S. Blake, B.C.C., '94, Assistant Instructor in Academic Department, October 1, 1894. Transferred to Male Grammar School No. 1, January, 1899.

Ralph L. Williams, B.P.I., '93, Assistant Instructor in Academic Department, October 1, 1894. Lost at sea, July 4, 1898.

Frederick W. Wild, Instructor in Sheet Metal Department from December 1, 1894, to September 17, 1900.

B. Harrison Branch, B.M.T.S., '92, Assistant Instructor in Academic Department and Assistant in Machine Department, October, 1896. Resigned, April, 1898.

Samuel P. Platt, Instructor in Mechanical Drawing and Descriptive Geometry, October 1, 1897.

J. C. Mattoon, B.M.T.S., '90, Assistant Instructor in Academic Department, November 1, 1897. Resigned, February, 1898.

Oliver Bacharach, B.C.C., '97, Assistant Instructor in Academic Department, April, 1898. Assistant Instructor in Mathematics, September 16, 1901.

William P. Gundry, B.M.T.S., '90, Assistant Instructor in Academic Department, April, 1898. Resigned, December 31, 1901.

J. Edward Broadbelt, Ph.G., B.M.T.S., '90, Assistant Instructor in Academic Department, September, 1898. Secretary and Assistant Instructor in Science, September 16, 1901.

John H. DeValin, Instructor in Forge Work from September, 1898, to September 17, 1900.

William R. King, Passed Assistant Engineer, U. S. N, (retired), U. S. N. A., '75, President and Instructor in Engineering and Applied Mechanics, September 1, 1899. Principal and Head of Department of Engineering, June 12, 1901.

John H. Bramble, B.C.C., '96, Assistant Instructor in Academic Department, October, 1899. Assistant Instructor in Mathematics and Science, September 16, 1901. Assistant Instructor in Mathematics, September 15, 1902.

John Montgomery Gambrill, B.P.I., '97, Instructor in History, Civics, and Literature, June 11, 1902. Resigned to become Assistant State Superintendent of Education in Maryland, July, 1904.

Charles Ernest Conway, B.P.I., '02, Assistant in Department of Engineering and Applied Mechanics, June 11, 1902. At Lehigh University, 1903-1904. Assistant in the Department of Engineering and Applied Mechanics, 1904-1905.

George P. VonEiff, B.P.I., '02, Assistant in Department of Science, September, 1903. Resigned, June, 1904.

William L. DeBaufre, B.P.I., '03, Assistant in Departments of Engineering and Mathematics, September, 1903. At Lehigh University, 1904-1905.

Irving L. Twilley, A.M., Washington College, '92, Instructor in Department of English, September, 1903. Transferred to the Department of Science as Instructor in Physics and Physical Geography, June, 1904.

Henry A. Converse, A.B., Hampden-Sidney College, 1893; Ph.D., Johns Hopkins University, 1903, Instructor in Mathematics, May, 1904.

Edward Reisler, A.M., Western Maryland College, '88, Instructor in History, Civics, and Composition, May, 1904.

Elmer M. Harn, A.B., Rock Hill College, 1892; A.M., Rock Hill College, 1895. Instructor in History, Literature, and Composition, July, 1904.

Isaac L. Otis, A.B., New York University, 1899, Instructor in Literature and Composition, September, 1904.

Harry M. Mason, B.P.I., '04, Assistant in Department of Science, September, 1904.

Allen L. Malone, B.P.I., '02, Instructor in Engineering Materials and Forge Work, October 1, 1904.

Board of School Commissioners.

JOSEPH PACKARD, *President*,
DR. IRA REMSEN,
ALCAEUS HOOPER,
REV. WILLIAM ROSENAU,
CHARLES H. EVANS,
JAMES H. PHILLIPS,
COL. A. B. CUNNINGHAM,
THOMAS McCOSKER,
B. HOWARD HAMAN.

Board of Visitors.

ABRAM H. COLMARY, *Chairman*,
FREDERICK W. WOOD,
FREDERICK J. MAYER,
GUSTAVUS W. LEHMANN,
JAMES L. MURRILL,
WILLIAM H. ROTHROCK,
MENDES COHEN.

Superintendent of Public Instruction.

JAMES H. VAN SICKLE.

Calendar for School Year, 1904-1905.

September 13, Tuesday	Opening of Session.
November 24, Thursday	Thanksgiving Day.
November 28, Monday	Second Quarter begins.
December 23, Friday	Christmas Vacation begins.
January 2, Monday	Christmas Vacation ends.
January 30 to February 10	Semi-Annual Examinations
February 13, Monday	Third Quarter begins.
February 22, Wednesday	Washington's Birthday.
April 3, Monday	Fourth Quarter begins.
April	Arbor Day.
April 20, Thursday	Easter Vacation begins.
April 24, Monday	Easter Vacation ends.
May 15, Monday	Annual Examinations begin.
May 30, Tuesday	Decoration Day.
June 13, Tuesday	Commencement Day.
September 13, Wednesday	Opening of Session.
November 30, Thursday	Thanksgiving Day.
November 27, Monday,	Second Quarter begins.
December 25, Monday	Christmas Vacation begins.

6/25/7
Pre-1923

Faculty.

WILLIAM R. KING, U. S. N., *Principal*
and
Head of Department of Engineering.

RICHARD H. UHRBROCK, Ph.B., *Acting Vice-Principal*
and
Head of Department of Mathematics.

WILLIAM H. HALL,
Head of Department of Science.

SAMUEL M. NORTH,
Head of Department of English, including History and Language.

Staff.

JOHN WARD WILLSON, M. D.,
German, and Science.

SAMUEL P. PLATT,
Mechanical Drawing and Descriptive Geometry.

OLIVER BACHARACH,
Mathematics.

JOHN H. BRAMBLE,
Mathematics.

JOHN EDWARD BROADBELT, Ph.G.,
Secretary and Science.

WARREN S. SEIPP,
Drawing.

IRVING L. TWILLEY, A. M.,
Science.

HENRY A. CONVERSE, Ph.D.,
Mathematics.

EDWARD REISLER, A.M.,
Civics, History, and Composition.

ELMER M. HARN, A.B., A.M.,
English and History.

ISAAC L. OTIS, A.B.,
English.

CHARLES ERNEST CONWAY,
Engineering.

HARRY M. MASON,
Graduate Assistant in Science.

Mechanical Department.

WILLIAM G. RICHARDSON,
Machine Work and Engineering Materials.

THOMAS G. FORD,
Pattern-Making and Wood-Turning.

WILLIAM A. JONES,
Sheet Metal Work.

GEORGE M. GAITHER,
Carpentry and Wood-Carving.

ALLEN L. MALONE,
Engineering Materials and Forge Work.

Course of Study and General Statement of Plan and Purpose.

The course of study for the Baltimore Polytechnic Institute is designed to accomplish the following purposes:

1. To give a sound fundamental education to pupils whose inclinations and other circumstances preclude a college course.

2. To give to youth that healthful and highly valuable manual training which broadens education, and conduces to dexterity, contrivance, and invention.

To this end the time usually devoted to Greek and Latin is employed, during two years of the course, in carpentry, sheet-metal, and light forge exercises. These exercises cover what is known as Manual Training, and are given with special reference to their educational value.

3. To give to students in the third and fourth years such studies in Mathematics, Physics, and Chemistry, and such mechanical exercises in Applied Manual Training as will fit them:

(*a*) For teaching in Manual Training Schools.

(*b*) For immediate and remunerative employment in the drafting-room, or for engagements in the wide field of electrical and mechanical engineering, where it is believed, their training will lead to rapid advancement.

(*c*) For entrance to advanced standing into an institution of technology, should a higher technical education be desired.

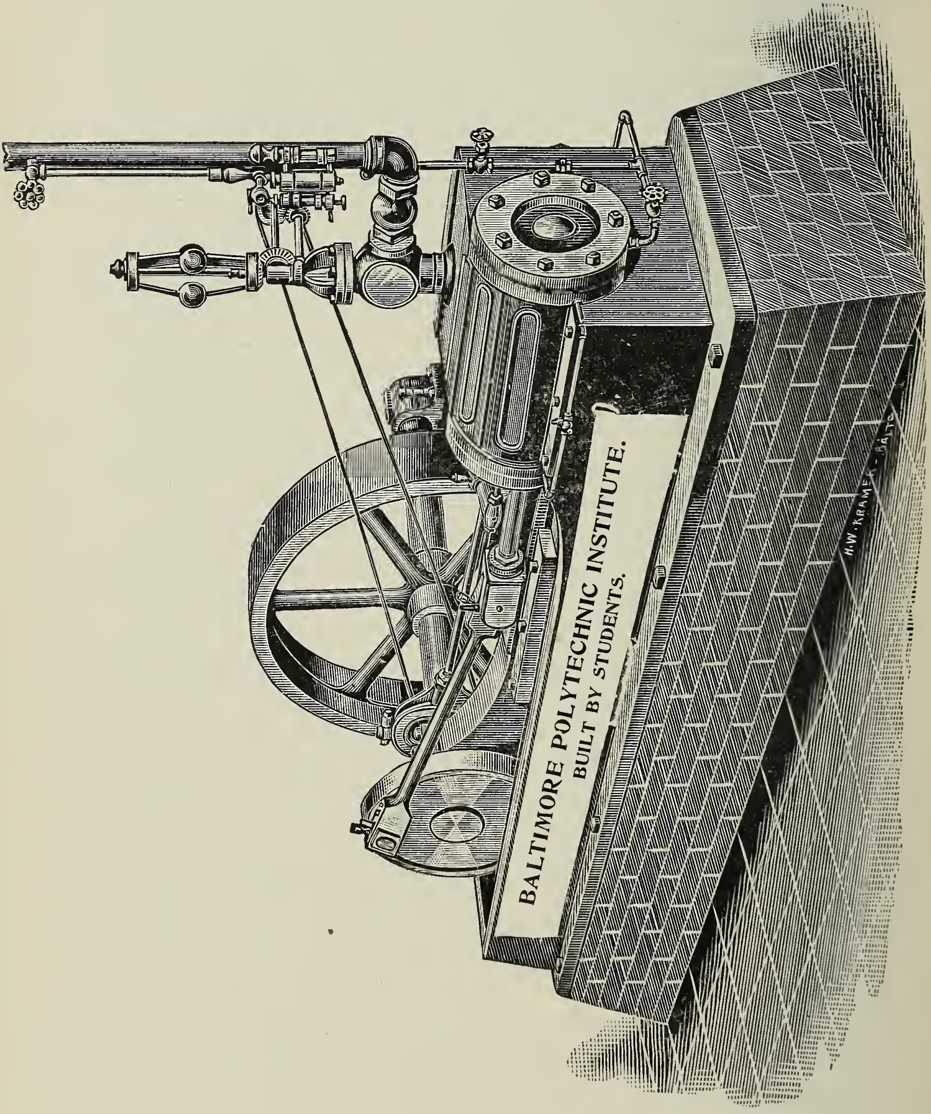
For the attainment of these objects there is one carefully planned general course of study, no effort being made to specialize until the fourth year, by which time a student will have acquired a considerable degree of practical skill and intimate knowledge in some one of the professions based on mechanical art and applied science that he may have elected to follow. Thus, for example, the student who may, toward the end of the course, elect to follow electrical engineering as a profession, will be afforded special opportunities for laboratory practice in the manipulation of currents, methods of testing, etc. The student who elects to follow mechanical or steam engineering as a life work, studies the elements of the theory of construction and operation of machines, special attention being given to the theory of the steam engine. In the drawing-room he is given elementary work in engine and machine design, and in the shops he does some actual work in engine and machine building.

No attempt is made to teach trades, but the equipment is of such a nature that the instruction given in the shops is designed to be correlative to the work of the class-room, and results are aimed at that will insure success in mechanical pursuits subsequent to graduation. It is believed that instruction in correct methods of using tools, and practical illustrations of how, and for what purpose, things are done, are of more value than mere excellence in hand skill.

Instruction in the English Department is given during the first, second, and third years, and embraces Composition, Rhetoric, Literature, History, and Civics. Special effort is made to inculcate sound principles in the choice of words and in phraseology, and frequent written exercises in the various kinds of composition are required of the student. The first year work in History is followed in the second year by a course in Civics, which is designed to ground the student in the fundamental principles of government and to emphasize their application to American citizenship.

The instruction in German during the second and third years, and in French during the fourth year, is designed to give a reading, rather than a speaking knowledge of these languages, in order to meet entrance requirements of institutes of technology.

In Mathematics, care is taken at the beginning of the first year to discover and correct any defects in fundamental training, after which the course of instruction proceeds in Algebra, Geometry, Trigonometry, and Analytical and Descriptive Geometry. During the fourth year the instruction given in the Engineering Department in Dynamics and Thermodynamics


BALTIMORE POLYTECHNIC INSTITUTE.
BUILT BY STUDENTS.
H.W. KRAMER - BALTO

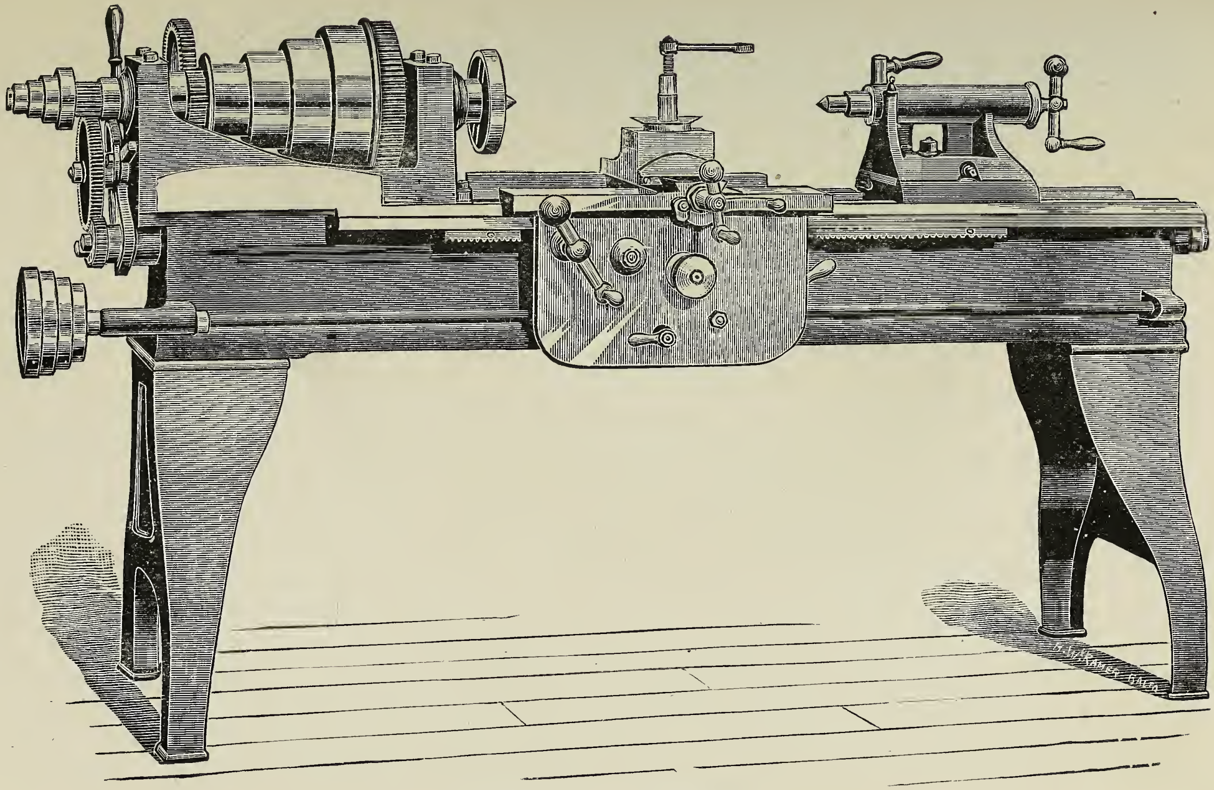
involves in its very elements the use of equations and mathematical principles which can be understood only by resort to the Calculus. For this reason instruction in the Differential and Integral Calculus is indispensable. The course is sufficiently broad to fit students for more advanced work, and includes the fundamentals of differentiation and integration, the development of the theorems of Taylor and Maclaurin, and applications of the subject to questions of maxima and minima, areas, volumes, and moments of inertia. Without such instruction, a student at graduation will be unable to read understandingly a treatise of any of the mechanical sciences.

In Physics, the work of the first and second years embraces the properties of matter and elementary mechanics, the instruction being accompanied with lectures illustrated by experiments, and with practical work in the laboratory. The instruction of third and fourth year students in this subject is confined to Heat and Electricity. The dynamic theory of heat, the conversion of heat into mechanical work, and the thermodynamics of the steam engine are the particular features of the fourth year in the study of Heat.

In Electricity, the work of the fourth year consists of practical applications of the theoretical study of the second and third years, and of commercial electricity. Electric lighting, both arc and incandescent, is discussed from constructive and economic standpoints, especially high and low voltage distribution. The dynamo and motor are treated in detail—operating, designing, and winding being carefully considered. The experimental equipment for this work consists of a twenty-five kilowatt generator, built by the students; a one-half horse power alternating current motor coupled to a twenty-five volt multipolar generator; and several smaller machines of various types. These appliances, with the electric light equipment of the Institute, present opportunities for personal observations and operation of electrical machinery and the various defects and faults to be overcome. Alternating currents are treated both mathematically and experimentally, and converters, motors, impedance coils, and measuring instruments are used by students for verifying laws and descriptions given in lectures. The main and laboratory switchboards and the generating plant afford opportunities for power-station practice, and the electric railway is treated in a practical manner. The newest and best methods of telegraph and telephone construction are presented, the telephones of the Institute being installed on the central-energy plan. Special features of the course are the various tests for insulation resistance of conductors, the tests for grounds, faults, and short circuits on lines, and the treatment of the defects in the dynamo and motor, and remedies therefor.

For the study of Chemistry there are chemicals and apparatus in the laboratory to give to the third year students instruction concerning the nature and reactions of the chemical elements and their compounds, and to students of the fourth year a brief course in qualitative and quantitive analysis, the compounds formed in the various reactions and their chemical equations being particularly emphasized.

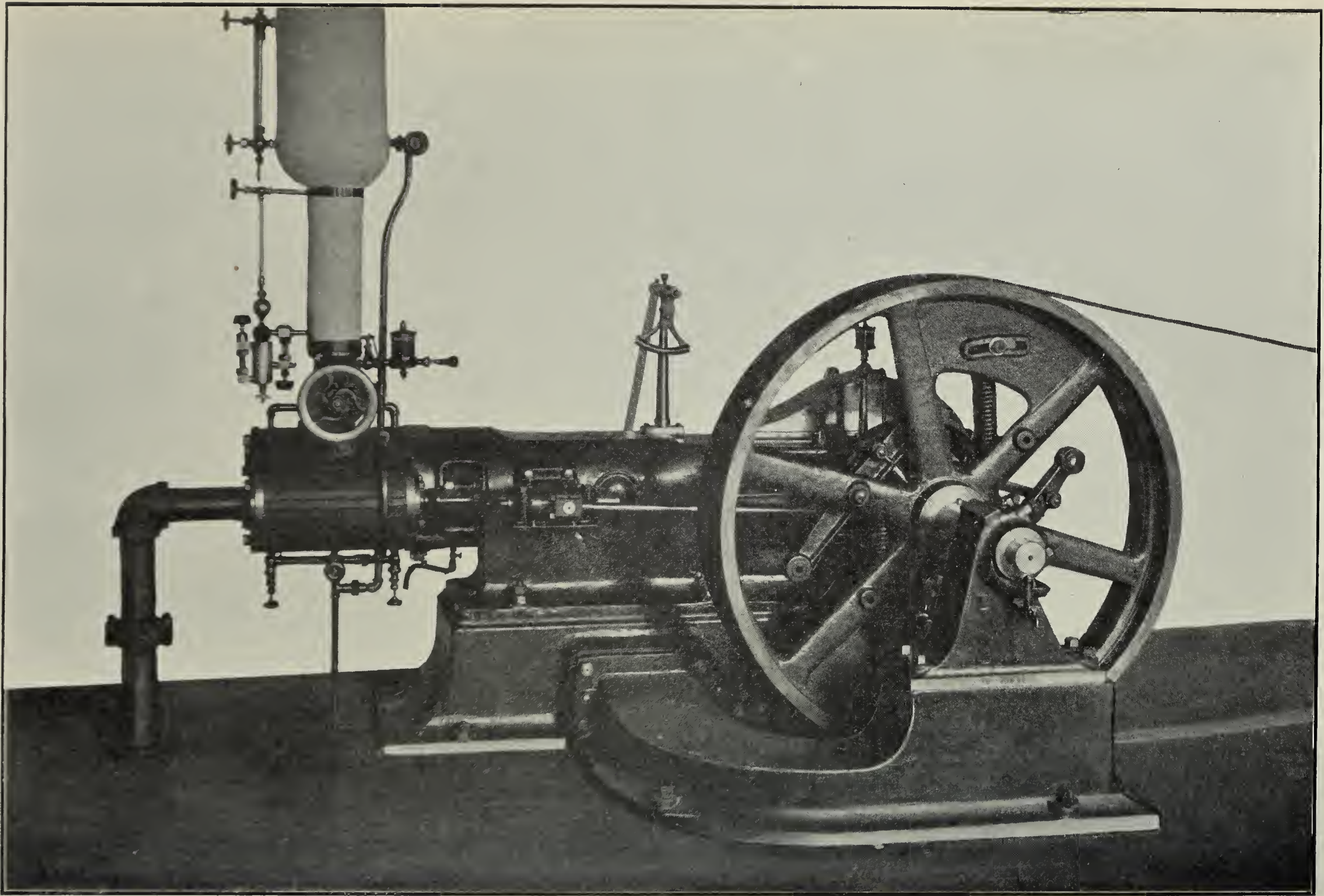
In the Department of Engineering the instruction given the fourth year students in theoretical and applied mechanics, which extends well into the Sophomore year of an institute of technology, embraces the laws of equilibrium and motion; centre of gravity; friction; principles of work; moments of inertia; mechanics of materials; and an elementary study of the stresses and deformations produced in standard specimens of metals when subjected to tension, compression, and shearing. The work of the third and fourth year students in steam engineering consists of the study of thermodynamics of the steam engine in as comprehensive a manner as the facilities of the Institute and the maturity of the students permit. Numerous calculations are made involving engine and boiler efficiencies and proportions, and the study of the indicator is supplemented with practice in taking diagrams, from which the consumption and distribution of the steam, and the power of the engine are determined. The advantages and disadvantages of the different kinds of steam boilers are studied, particular attention being given to such attachments as separators, feedwater heaters, and mechanical stokers. The plant for this work consists of an inverted triple expansion engine of 100 I. H. P., an inverted compound engine of 60 I. H. P., a high speed automatic cut-



BUILT BY STUDENTS.

off engine (Harrisburg standard) of 46 I. H. P., a horizontal power engine of 25 I. H. P., a Campbell & Zell sectional boiler (rated at 100 horse-power), and a Roberts safety water tube boiler, capable of generating steam for the production of 120 I. H. P. when used in connection with the triple expansion engine. The engines mentioned above were built by the students, the first two after designs of the Bureau of Steam Engineering of the Navy Department. Grouped in the mechanical laboratory are all the engines, the 25 K. W. generator, the switchboard controlling the lighting installation of the Institute, and a Riehle testing machine of 50,000 pounds capacity. The compound and triple expansion engines may be worked singly or together in connection with a friction dynamometer especially designed at the Institute, an internal circulation of water in the brake wheel enabling the engines to run continuously in making power tests. The Roberts boiler is installed in a room immediately connected with the laboratory, and furnishes steam at 150 pounds pressure per square inch for the stage expansion engines, and at 95 pounds and 40 pounds to the high speed and power engines, respectively, Foster regulators reducing the pressure as desired. Horizontal and vertical separators are placed in the steam pipes to insure the delivery of dry steam to the engines, and connections are made for calorimeter tests. The surface condenser used in connection with the stage expansion engines may also be connected with the exhaust of the high-speed engine when desired. The water from condensation is delivered to a filter of approved design by a Knowles independent air pump, and thence direct to the boiler, either by a Dean pump or Penberthy injector. For purposes of economy tests of the engines and boiler, the feed water is made to pass through weighing tanks of galvanized iron.

In the mechanical drawing-room are ninety-five tables of approved design, and an equipment of instruments and models well adapted to the requirements of an advanced course in the subject. Fourth-year students are required to make a freehand sectional sketch of some machine, from which a finished



HIGH SPEED AUTOMATIC CUT-OFF ENGINE (HARRISBURG STANDARD).

BUILT BY CLASSES OF 1901 AND 1902.

drawing, tracing, and blue print are made, and their work in design tends to make them draftsmen in the truest sense—not mere copyists.

The material equipment in the machine, pattern, forge, sheet metal, and carpentry shops is equal, and in some respects superior, to that of any similar institution in the country.

The Course of Instruction in Detail.

Note.—Students completing the course as here outlined obtain full Sophomore standing with some Sophomore credits in the courses leading to the degrees of M.E., E.E., and C.E. at Cornell and Lehigh universities.

Department of Engineering and Applied Mechanics.

FIRST YEAR COURSE—D CLASS.

Lectures and Practical Exercises.

(*a*) *Carpentry.*—16 weeks, 6 periods a week.

(*b*) *Sheet Metal.*—16 weeks, 6 periods a week.
Soldering; sheet metals; Venetian iron and repousse work.

(*c*) *Mechanical Drawing.*—32 weeks, 4 periods a week.
Use of instruments; lettering; elementary lessons.

SECOND YEAR COURSE—C CLASS.

Lectures and Practical Exercises.

(*a*) *Review of Carpentry.*—4 weeks, 6 periods a week.

(*b*) *Introductory Vise Work.*—8 weeks, 6 periods a week.

(*c*) *Forge.*—8 weeks, 6 periods a week.
Light forging and welding.

(*d*) *Pattern.*—12 weeks, 6 periods a week.

(*e*) *Mechanical Drawing.*—32 weeks, 5 periods a week.
Hatching; tinting; neatness and accuracy; scale drawing.

THIRD YEAR COURSE—B CLASS.

Steam and the Steam Engine.—32 weeks, 4 periods a week.
Early history and progress of steam engineering; combustion of fuel and steam generation; efficiency; economy of fuel; the indicator; horse power; the slide valve.

Mechanical Drawing.—32 weeks, 4 periods a week.

Detail drawings of machines from free-hand sketches; the working drawing, tracing and blue print. Descriptive Geometry (see course in Mathematics).

Practice.—(*a*) Pattern Shop; 16 weeks, 6 periods a week.

Exercises in making patterns for wrenches, pulleys, eccentrics, pillow-blocks, gears, globe valves, pipe joints, and core boxes where necessary.

Lectures on construction and finish of patterns; green sand molding, open sand molding, loam molding, mixing of iron and of brass, and on the operation of the cupola.

(*b*) Machine Shop, Forge Shop, and Laboratory; 16 weeks, 6 periods a week.

Work on the lathe, planer, milling machine, drill-press, and vise. Forging and tempering machine cutting tools; casehardening; chasing. Valve setting; operating engines and taking indicator diagrams.

FOURTH YEAR COURSE—A CLASS.

Lectures and Recitations.—32 weeks, 3 periods a week.

Steam and the Steam Engine.—Thermodynamic applications; the laws of Charles and Boyle; kinetic theory of heat; absolute zero of temperature; the expansion of gases, with particular reference to different conditions of steam expansion; details of steam engine; link motion; clearance and compression; indicator diagrams—theoretical and actual; steam consumption per unit of power; mean effective pressure; stage expansion engines; condensers; boilers; engineering materials.

Mechanics.—32 weeks, 4 periods a week.

First Principles.—Matter; mass; inertia; velocity; acceleration, force; absolute measure of force; gravity; gravitation units of measure; comparison of gravitation and absolute measure of force.

Kinematics.—Motion in a straight line with a constant acceleration; falling bodies; resolution and composition of velocities; the conversion of motion; harmonic motion; velocity ratios.

Dynamics.—(*a*) Statics.—The parallelogram, triangle, and polygon of forces; composition and resolution of forces; conditions of equilibrium; transmissibility of force; parallel forces; moments of forces and of couples; conditions of equilibrium of a body under the action of three forces in one plane; centre of gravity; friction; virtual velocities; the mechanical powers. (*b*) Kinetics.—The laws of motion; centripetal and centrifugal forces; kinetic energy, or vis viva, of a moving body; work.

Mechanics of Materials.—Stress; strain; elastic limit; ultimate strength; bending and resisting moments; moment of inertia; radius of gyration; simple and cantilever beams; struts; deflection; torsion; resilience; bending-moment and shear diagrams.

Graphic Statics.—The funicular polygon; the reciprocal diagram for determining stresses in framed structures.

Mechanics of Machinery.—Transmission of power by means of belts and toothed-gears; theory and action of pumps.

Design and Mechanical Drawing.—32 weeks, 4 periods a week.

Design.—Some part of an engine or of a tool, such as cylinder, connecting rod, valve, screw-jack; Zeuner diagram.

Mechanical Drawing.—The drafting accompanying the work in design; free-hand sketches, from which are made the finished drawing, the tracing, and the blue print.

Practice.—32 weeks, 2 periods a week.

Actual running and indicating of steam engines; testing for tension, compression, and flexure with a Riehle machine; machine work involving accuracy and finish; economy tests of engines and boilers; calorimeter tests for quality of steam.

Department of Mathematics.

FIRST YEAR COURSE—D CLASS.

Explanation and Demonstration.—32 weeks, 2 periods a week.

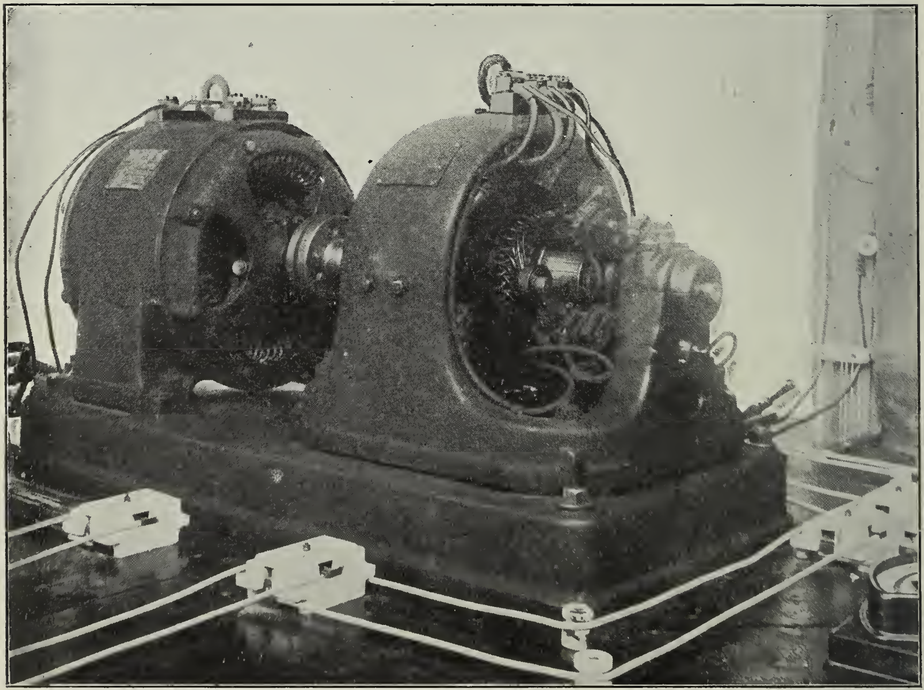
The most difficult and important features of the course are explained and demonstrated by the instructors.

Algebra.—32 weeks, 4 periods a week.

Fundamental operations; integral equations; factors and multiples; fractions; simultaneous linear equations; inequalities; indeterminate linear equations; involution; evolution; surds; imaginary and complex numbers; doctrine of exponents; the reduction and solution of quadratic equations; ratio and proportion; arithmetical, geometrical, and harmonical progressions; permutations, combinations; binomial theorem.

Geometry.—32 weeks, 3 periods a week.

Geometry of the straight line and circle; proportion; properties of similar figures; original exercises.



WESTINGHOUSE MOTOR-GENERATOR.
USED IN LABORATORY.

SECOND YEAR COURSE—C CLASS.

Geometry.—16 weeks, 4 periods a week, and 16 weeks, 3 periods a week.

Areas of polygons; regular polygons; circles; lines and planes in space; polyhedrons; cylinder; cone; sphere; original exercises.

Advanced Algebra.—16 weeks, 2 periods a week.

Comprehensive review of the work of the preceding year from surds; partial fractions; binomial theorem; logarithmic usage; exponential and logarithmic series.

Plane Trigonometry.—16 weeks, 3 periods a week.

Functions of the acute angle; the right triangle; use of tables; goniometry.

THIRD YEAR COURSE—B CLASS.

Plane Trigonometry.—10 weeks, 3 periods a week.

The oblique triangle; miscellaneous examples.

Spherical Trigonometry.—12 weeks, 3 periods a week.

The right spherical triangle; the oblique triangle; applications of spherical trigonometry.

Surveying.—10 weeks, 3 periods a week.

Instruments and their uses; land surveying.

Analytic Geometry.—32 weeks, 4 periods a week.

The straight line; circle; parabola; ellipse; hyperbola; transformation of co-ordinates; construction of loci; higher plane curves.

Descriptive Geometry.—Time taken from mechanical drawing, as the subject is taught in conjunction with that subject.

Projections; problems in straight line and plane; projections and sections of solids; curved surfaces and tangent planes; development and projection of screw threads; intersection of surfaces.

FOURTH YEAR COURSE—A CLASS.

Differential and Integral Calculus.—32 weeks, 5 periods a week.

Differentiation of algebraic and of transcendental functions; successive differentiation; expansion of functions, including the development of Maclaurin's and of Taylor's theorems; evaluation of indeterminate forms; mode of variation of functions of one variable, including geometric problems in maxima and minima; differentiation of functions of more than one variable; tangents and normals; derivatives of arcs, areas, volumes, and surfaces of revolution; circle of curvature; radius of curvature; fundamental rules and methods of integration; geometrical applications of the calculus to lengths of curves, to areas, to volumes of solids of revolution; integration of trigonometric functions; successive integration; applications to mechanics.

Department of Physics and Chemistry.

FIRST YEAR COURSE—D CLASS.

General Physics.—32 weeks, 2 periods a week.

Properties of matter; C. G. S. units; falling bodies; work and power; elementary mechanics; specific gravity; elements of hydromechanics; pressure and expansion of air; lectures illustrated by experiments.

Physical Geography.—32 weeks, 2 periods a week.

The subject is taught by lectures, demonstrations, and recitations, the relation between physiographic conditions and commercial and agricultural products being emphasized.

SECOND YEAR COURSE—C CLASS.

Heat.—32 weeks, 2 periods a week.

Thermometers; calorimetry; coefficients of expansion; boiling points; distillation; latent heat; laws of thermodynamics; mechanical equivalent of heat. Practical work in laboratory.

Electricity.—32 weeks, 2 periods a week.

Magnetism; currents; induction; static electricity; lectures and experiments.

THIRD YEAR COURSE—B CLASS.

Electricity.—32 weeks; 3 periods a week.

Deduction of formulæ; use of galvanometers; magnet testing; laws of induction; simple alternating currents; relation of electricity to work and power; practical work in laboratory.

Chemistry.—32 weeks, 2 periods a week.

Recitations in general chemistry; experiments illustrating text.

FOURTH YEAR COURSE—A CLASS.

Electricity.—32 weeks, 4 periods a week.

Lectures and recitations in applied electricity, including electrochemical action; principles of the dynamo, motor, and transformer; railways; line and machine testing; telegraph and telephone; electric lighting; practical work in laboratory.

Chemistry.—32 weeks, 4 periods a week.

Theory of analysis; qualitative analysis of solutions containing one base and one acid; qualitative analysis of solution containing several salts; qualitative analysis of powders; quantitative analysis of silver, ammonia, and iron solutions by volumetric method; quantitative analysis of solutions for barium and phosphoric acid by gravimetric method; simple determinations of carbon, sulphur, manganese, and silicon, in iron and steel.

Department of English, including History and Language.

FIRST YEAR COURSE—D CLASS.

Composition and Rhetoric.—32 weeks, 2 periods a week.

Study of text and frequent written exercises in paragraphing and sentence structure, based upon Narration and Description; Letter Writing.

Literature.—32 weeks, 2 periods a week.

(*a*) Leading facts in the lives of representative American writers.

(*b*) Reading and study in class of the following selections: Legend of Sleepy Hollow, Forest Hymn, Evangeline, The Gold-Bug, Snow-Bound, Vision of Sir Launfal, Tales of the White Hills.

History.—32 weeks, 3 periods a week.

The course includes Greek and Roman History, and the subjects are taught both chronologically and topically.

SECOND YEAR COURSE—C CLASS.

Composition and Rhetoric.—32 weeks, 2 periods a week.

Study of text and frequent written exercises upon the Sentence, the Paragraph, and the Whole Composition.

Literature.—32 weeks, 2 periods a week.

(*a*) Leading facts in the lives of representative English writers since Pope's time.

(*b*) Study in class of the following texts: The Vicar of Wakefield, Ivanhoe, Silas Marner, The Deserted Village, The Lady of the Lake, The Ancient Mariner.

German.—32 weeks, 3 periods a week.

Study of the grammar, and reading.

Civics.—32 weeks, 2 periods a week.

The principles of government and their applications to American citizenship.

THIRD YEAR COURSE—B CLASS.

Literature.—32 weeks, 2 periods a week.

Study of the works selected for 1905 by the Committee on Uniform Entrance Requirements. The works prescribed are Macbeth, Macaulay's Essays on Milton and Addison, Burke's Speech on Conciliation with America, and Milton's Comus, Lycidas, Il Penseroso, and L'Allegro. Frequent written exercises.

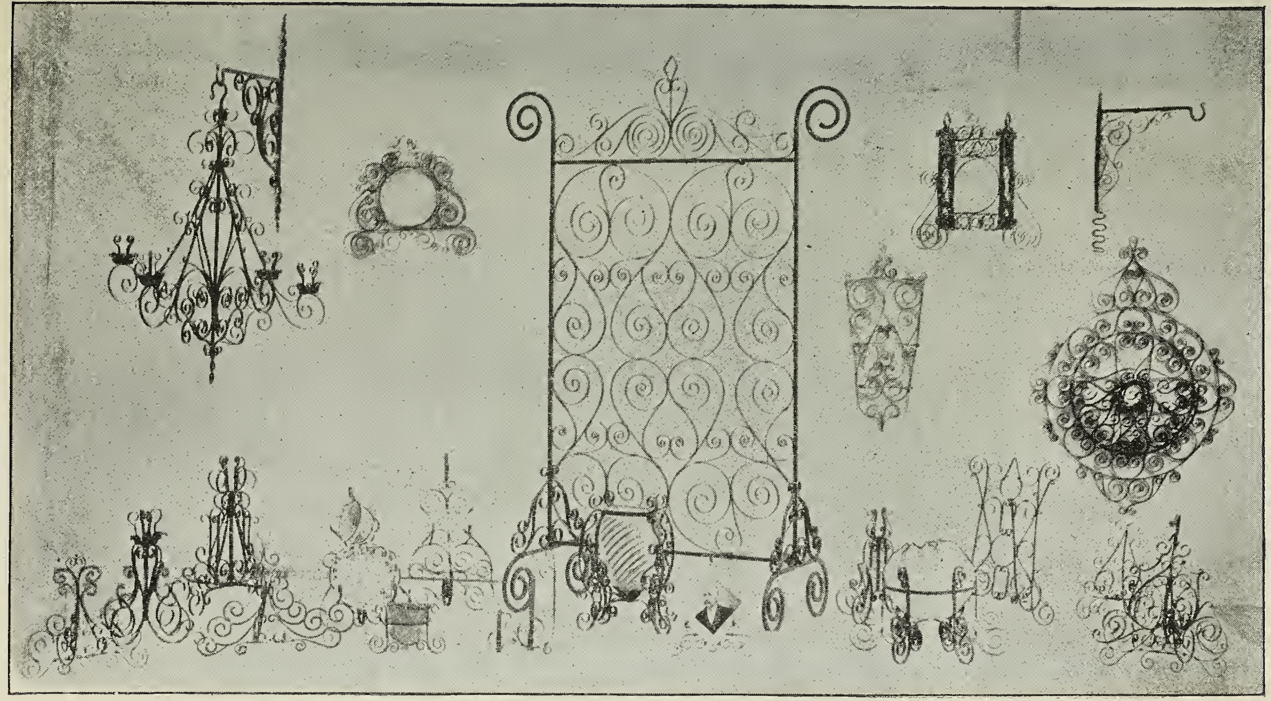
German.—32 weeks, 2 periods a week.

Composition, and reading easy prose on scientific topics.

FOURTH YEAR COURSE—A CLASS.

French.—32 weeks, 4 periods a week.

Study of the grammar, and reading simple science.



VENETIAN IRON WORK.

Requirements for Admission.

Pupils bearing properly attested certificates of having passed the prescribed Grammar School Course of the Public School System of Baltimore are entitled to enrollment.

Other applicants residing in the city will be admitted after passing an examination covering the requirements of the eighth grammar school grade. Eighth grade grammar school pupils who failed of promotion are not eligible for admission under this requirement. Specimen entrance examination papers covering the requirements of the eighth grade will be found on pages 62, 63, and 64.

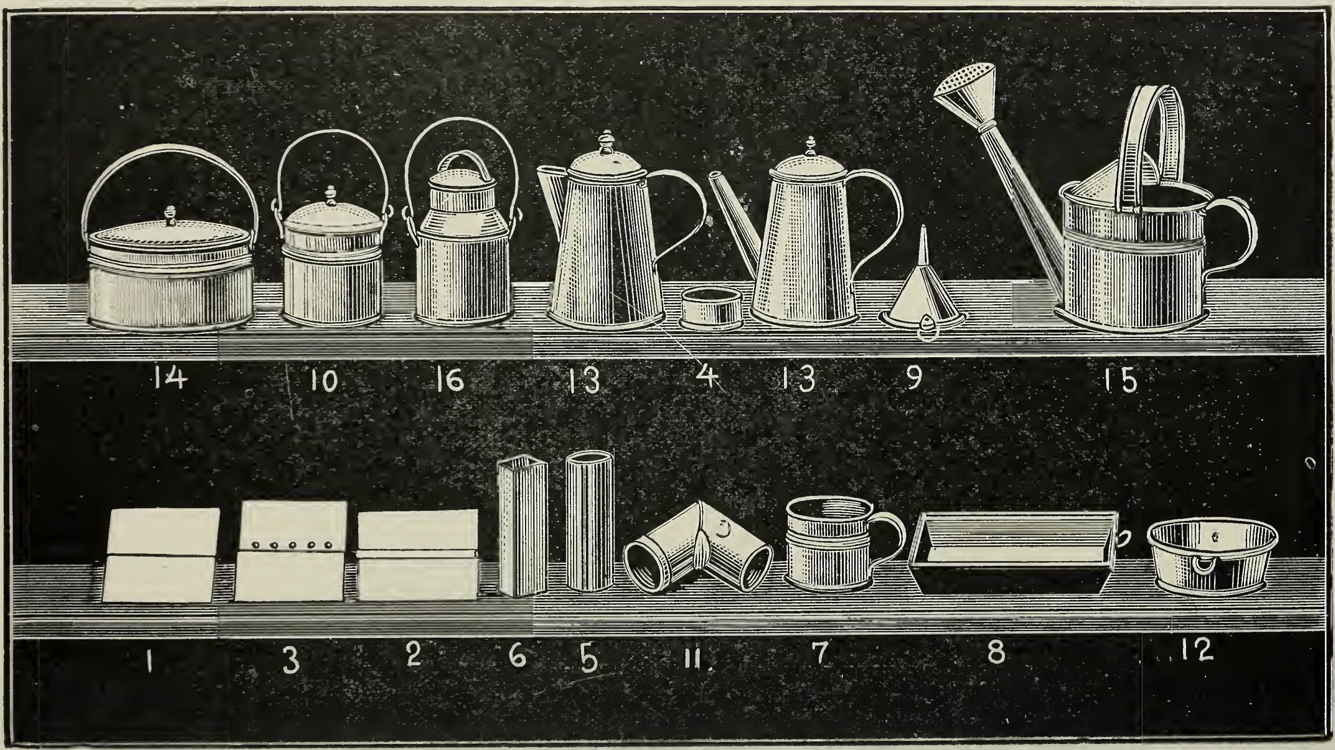
Non-resident applicants, in addition to passing the entrance examination, are required to pay an annual fee of $72.00, charged for tuition and for the use of books.

After having successfully passed the entrance examination, a non-resident applicant must register as such at the office of the Secretary of the Board of School Commissioners, where he will be furnished with a bill for the first quarterly installment of the fee; and a presentation at the Institute of a coupon from the bill, signed by the City Comptroller, will be accepted as evidence of payment, and entitle the applicant to enrollment.

Merit Rolls.

Merit rolls, showing the proficiency of students in each branch of study, are made out annually for the different classes.

Each subject is assigned a coefficient indicative of its relative weight; and the final mark of a student in a subject (on a scale of 100) is multiplied by its coefficient. The sum of the products is the final mark of the student for the year. This mark is a certain percentage of the sum of the coefficients, and such percentage is the student's average for the year.

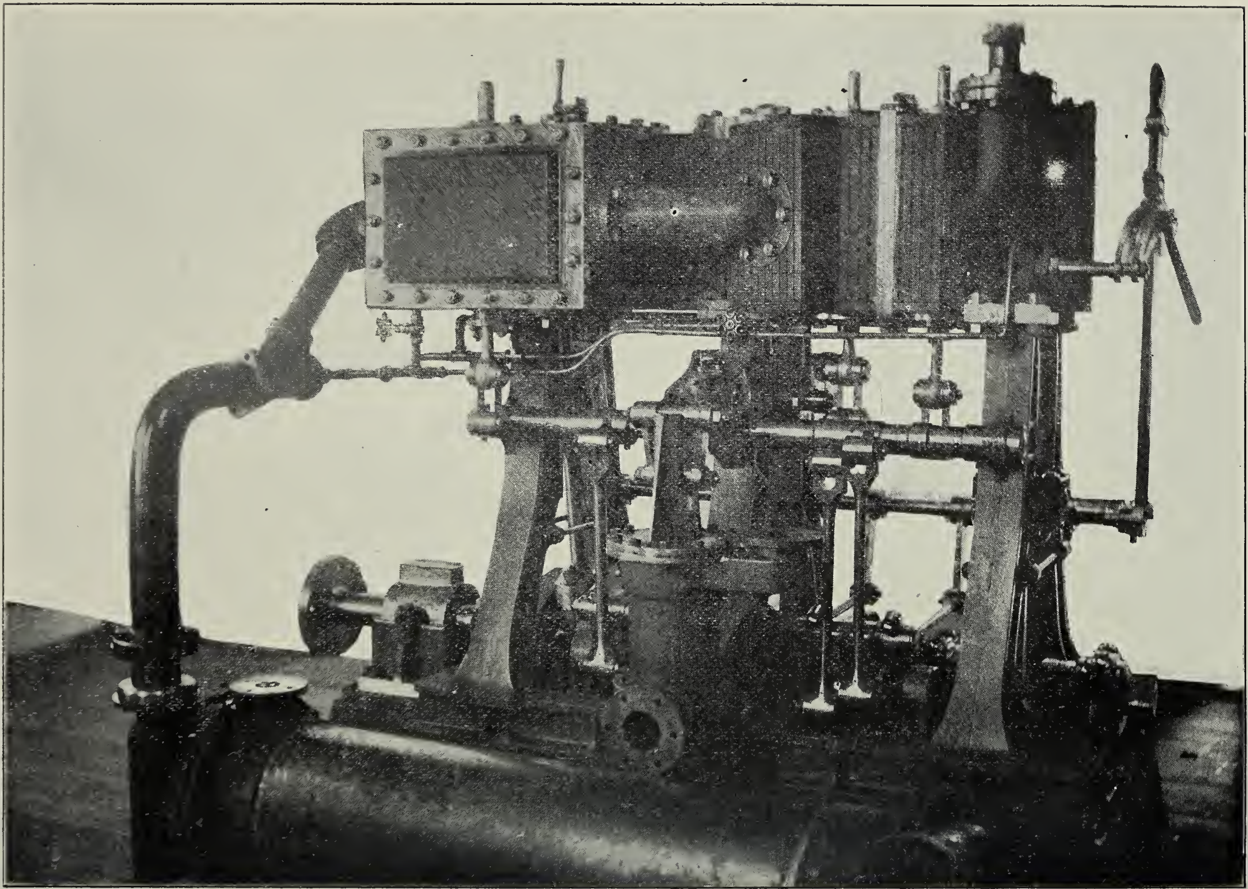


TIN WORK·

BALTIMORE POLYTECHNIC INSTITUTE

FINAL MERIT ROLL AND FOURTH YEAR RECORD OF GRADUATING CLASS OF 1904.

Order of Merit.	NAMES.	Date of Admission.	Mechanics.	Mechanics of Materials.	Steam Engineering.	Mech. Drawing and Design.	Diff. and Integral Calculus.	Chemistry.	Applied Electricity.	French.	Practice.	Deportment.	Aggregate for 4th Year.	Aggregate for 3rd Year.	Aggregate for 2nd Year.	Aggregate for 1st Year.	Aggregate for 4th, 3rd, 2nd, & 1st Yrs.	Graduating Average.
	MAXIMA.		**7**	**10**	**10**	**8**	**10**	**10**	**10**	**5**	**5**	**5**	**80**	**60**	**40**	**20**	**200**	**100**
7	P. W. Backhaus.	1898	No. 9 5.25	No. 4 8.60	No. 7 7.80	No. 4 6.56	No. 6 7.90	No. 5 9.10	No. 3 8.40	No. 3 4.15	No. 5 4.20	No. 10 3.00	64.96	51.40	32.73	14.07	163.16	81.58
8	H. W. Brannan..	1898	No 3 5.53	No. 5 8.50	No. 4 8.00	No. 7 6.08	No. 5 8.00	No. 3 9.20	No. 5 8.00	No. 6 3.75	No. 8 4.05	No. 1 5.00	66.11	49.12	31.10	15.99	162.32	81.16
10	W. N. Crisp.....	1900	No. 10 4.90	No. 7 8.30	No. 5 8.00	No. 9 5.92	No. 10 7.30	No. 8 8.70	No. 6 7.80	No. 8 3.55	No. 7 4.05	No. 9 3.75	62.27	45.64	29.59	15.77	153.27	76.64
5	E. Hering.......	1898	No. 5 5.46	No. 8 8.10	No. 9 7.50	No. 2 7.28	No. 9 7.40	No. 4 9.20	No. 7 7.70	No. 10 3.50	No. 2 4.45	No. 7 4.55	65.14	51.22	33.73	15.37	165.46	82.73
4	J. B. Jones	1900	No. 1 5.74	No. 3 8.80	No. 3 8.10	No. 8 6.00	No. 7 7.70	No. 7 8.90	No. 8 7.60	No. 5 3.80	No. 4 4.25	No. 6 4.65	65.54	53.04	34.61	17.01	170.20	85.10
1	M. Kraemer.....	1899	No. 2 5.60	No. 2 9.10	No. 1 9.30	No. 1 7.52	No. 1 9.10	No. 1 9.70	No. 1 8.60	No. 2 4.65	No. 1 4.75	No. 1 5.00	73.32	56.02	36.72	17.91	183.97	91.99
3	H. M. Mason, Jr.	1899	No. 7 5.25	No. 9 7.70	No. 6 7.90	No. 5 6.48	No. 3 8.40	No. 9 8.40	No. 9 7.30	No. 4 4.00	No. 10 4.00	No. 1 5.00	64.43	54.46	34.39	17.22	170.50	85.25
6	J. McD. Reid....	1898	No. 4 5.53	No. 5 8.50	No. 10 7.40	No. 10 5.76	No. 3 8.40	No. 5 9.10	No. 5 8.30	No. 9 3.50	No. 3 4.35	No. 1 5.00	65.84	50.04	32.19	16.09	164.16	82.08
9	M. J. Reynolds..	1898	No. 8 5.25	No. 10 7.30	No. 8 7.60	No. 6 6.24	No. 7 7.70	No. 10 8.20	No. 10 7.10	No. 7 3.65	No. 9 4.05	No. 8 3.80	60.89	47.20	31.57	14.21	153.87	76.94
2	G. F. W. Sims...	1900	No. 6 5.39	No. 1 9.20	No. 2 9.30	No. 3 6.56	No. 2 8.90	No. 2 9.50	No. 2 8.60	No. 1 4.75	No. 6 4.05	No. 1 5.00	71.25	54.58	34.56	17.50	177.89	88.9



TRIPLE EXPANSION ENGINE.

BUILT BY STUDENTS AFTER DESIGN OF THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT.

The Engineer and Mechanic as Factors in The World's Progress.

ADDRESS DELIVERED BY WILLIAM FREDERICK DURAND, PH.D., PROFESSOR OF ENGINEERING, STANFORD UNIVERSITY, ON THE OCCASION OF THE COMMENCEMENT EXERCISES OF 1904.

Few things are more inspiring than the broad perspective view from a lofty mountain, towering far above the surrounding plain with its features of hill and valley, dale and stream; and so I am going to ask you in my opening thought to go with me in spirit to the top of some such mountain whence we may survey in one bold sweep the world-civilization of the present day, note its foundations and chief factors, and in particular examine the part which has been played and which yet remains to be played by those activities which form our chief interest on the present occasion. The breadth and independence of view which I desire you to take is not unlike that which might be taken by an inhabitant of another planet, Mars, if you like, coming down to Earth and examining her institutions and the character of her civilization. What would such a visitor see on his visit to Earth and how would he classify his observations? What do we see from the top of our mountain?

We shall first note that the entire fabric of our civilization depends on the subdivision and partnership of human effort. So long as each man does for himself all things which are done, so long as he clothes himself, builds his own house, obtains his food in one way or another by his own hands, and thus is all things unto himself, so long we have the condition of savagery, and civilization, as we know it, is impossible.

"It appears then," we can imagine our visitor from Mars jotting down in his note book, "that the race of earth-dwellers have long since realized this fundamental principle, and by entering into a partnership of effort have achieved conditions of life quite impossible under scattered individual effort alone."

But what have we thus realized? What are some of the leading features of this civilization which has grown out of the last few thousand years of our occupancy of the planet Earth?

We may first note that life consists in living and in doing. There is the bare fact of existence for which certain things are needful and sufficient, and there is over and beyond this the life of action and achievement. Existence demands food, clothing, and shelter. Action and achievement demand multiplied and complex relations as illustrated in modern society, in which we find elements which minister to the upbuilding of mankind in his many aspects, physical, mental, and spiritual. We thus find that the world must not only be fed, clothed, and housed, but it must also be amused, instructed, governed, and protected or conserved.

From the view point of these broad generalizations the amusement of the world includes everything which ministers to the lighter and pleasurable emotions, and which may serve as a foil to the sterner and more serious aspects of life. Sports and games of all kinds; a large portion of the world's reading; music; the drama, in large part; recreations and amusements in the narrower sense; all these represent activities which minister to this fundamental need of humanity. The instruction of the world includes both mental and moral upbuilding as well as everything which ministers to our sense and appreciation of the beautiful. Schools, colleges, and all educational movements, most of the activities which have religion as a basis, fine art in its various manifestations, with some part of the world's reading matter—these include the more important activities which relate to the instruction of the world. The government of the world includes all the complex machinery by means of which the relations of man to his fellow are defined and maintained, and as represented in the activities of those who make laws and regulations, of those who execute them, and of those who deal with their interpretation or with cases of their infraction. Legislation, and legislative bodies of all kinds; executive officers, from the ruler of the nation to the policeman on his beat; courts and all judicial and legal activities; armies and navies in their relations to international questions; all of these owe their existence as factors in our civilization to the fundamental need of government.

The protection or conservation of the world includes all forms of activities which have primary relation to the defense or conservation of life with particular relation to disease and injury; and therefore includes primarily the activities of physicians, surgeons, and nurses, with hospitals and the equipment needed to make their efforts effective.

Any such classification of the world's activities is of course largely arbitrary and we shall place no great weight on these classes as defined, except as serving to call our attention, by their mere enumeration, to some of the more important types of world activities. Interwoven with these again, and in fact standing as an absolutely essential condition of their efficiency, we find the most astonishingly complex and extended systems of transportation and intercommunication. In fact, the one feature which perhaps best distinguishes the civilization of today from that of one hundred or four hundred years ago is the development in means of transportation and intercommunication between man and his fellow. The railroads, steamship lines, city and interurban electric lines on the one hand, with the telegraph, cable, telephone, and world-postal systems on the other, have reduced the effective size of the civilized world to less than the dimensions of a small state a few hundred years ago. The activities which are involved in the design, construction, and operation of these vast systems of transportation and communication form, therefore, a most important basic group having relation to all the other groups mentioned, and so interwoven with them that without this group our present civilization could not for a moment be maintained.

Now if we can hold in mind this vast perspective of world activities, let us ask in what relation to them all, the engineer and mechanic find their places as factors.

There is one fundamental fact which will enable us to gather up, so to speak, the activities of the engineer and mechanic into one view, and thus justly to evaluate their relations to the wide scope of world activities, and their position as factors in the civilization of the day.

This basic fact can be perhaps best expressed by the statement that the engineer and mechanic have immediate and special relations with the constructive materials and with the physical or non-organic forces and energies of nature. These constitute, so to speak, the raw material with which they must work, and which it is their duty to mould, transform, and bring into the service of mankind. In connection with the activities to which the work of the Baltimore Polytechnic Institute is most closely related, the engineer and mechanic stand in special relation to the non-organic energies of nature, and it is peculiarly their function to liberate, transform, and adapt these energies through suitable structures and mechanisms; and thus adapted, to apply them to the doing of the world's work. Wherever we find, therefore, in any item or feature of our present day civilization or of the activities of which it consists, any dependence on or relation with mechanical work or energy, there stands the evidence of the work of the engineer and the mechanic.

With this touchstone it becomes, therefore, possible to realize the far-reaching and fundamental importance of these callings in life as factors in the great problem of the world civilization.

It is not too much to say that the entire fabric of our present material civilization rests primarily and chiefly on the utilization of the energies of nature, and to this extent it depends, therefore, on the services of the engineer and the mechanic. If we think over our classification of the world activities, we realize this fact with ever increasing force. The feeding, clothing, and housing of the world, as well as its amusement, instruction, government, and conservation, depends at untold points on mechanical energy, and embodies that work which such energy furnishes as an essential element in their realization. Illustrations are perhaps scarcely needed, and yet may be allowed further to impress the point.

The loaf of bread which appears on our table is the result of a long series of operations including as an essential element and at almost innumerable points, mechanical work drawn from the energies of nature. The land in the far northwest may have been ploughed by the agency of the steam engine; and in any event it is sure that the plough, the grain drill, the reaper, and binder, and the entire series of farm implements are the embodiment of three main constituents: the materials of engineering construction, the application of mechanical work, and the genius and skill of the designer and builder. Again, the wheat is threshed and ground by steam, the barrel or paper bag in which it is placed is the product of ingenious machinery operated from some source of natural energy, and in itself designed and built by the engineer and mechanic. The flour again is mixed and kneaded by machinery to form the dough, and, in fact, the whole operation of breadmaking on a large scale is now dependent on mechanism and a supply of natural energy for its operation. Again, the transportation of the wheat from the farm to the elevator where it is stored, from the elevator to the mill where it is ground and put up in packages, from the mill to the bakery and from the bakery perhaps by automobile delivery wagon to your door, depends at every step upon mechanisms and energy; upon the immediate services of the engineer and mechanic for their operation; and upon the same services for their design and construction.

Again, if we should trace the history of the woolen garment, which shelters from the winter's cold, in its course from the back of the sheep to the merchant's counter, we shall find in the same way mechanism and mechanical work at every step running through the entire range of textile machinery for cleansing, combing, carding, spinning, and weaving the cloth, and for cutting and sewing it into garments. The same story is revealed in our cotton, linen, and silken fabrics, as well as in the straw and felt head-covering, and in the leather and rubber for the feet. In a very real sense, the finished garments represent the embodiment of mechanical energy with the raw materials of nature, combined and perfected in their forms of beauty and use by the genius and skill of those whose duty it is to deal with energy in the service of mankind.

Similarly with the timber, stone, or brick, which forms the walls of our dwellings, the shingle or tile which forms the roof, the glass which admits the light of heaven, or the nails and bolts which serve such varied uses in the building of the structure. Then again, in connection both with our clothing and dwellings, there comes in the element of transportation which carries the wool to the mill, the cloth to the merchant, and the garment to the wearer; or, again, the ore to the furnace, the steel to the wire mill, the wire to the nail factory, the nail to the store and to its place in the house.

Likewise with our amusements and pleasures. What would they be without our modern systems of travel and communication? Suppose there were no railroads, no trolley lines, no steamships, no mail and postal lines, no cable, telegraph, or telephone lines; or, again, suppose there were no manufactured toys or games or materials for sports and pastimes, no firearms for hunting; in short, suppose that there were no engineer or mechanic to interpret the possibilities inherent in the constructive materials and in the energies of nature; what would modern society do for amusement and pastime? Of scarcely less importance is the office of the engineer and mechanic in the world activities of instruction, in the broad sense in which we have used it, of government, and of conservation. Aside from the many important ways in which the exercise of these functions depends directly upon mechanical work and the utilization of natural energy, all are so dependent on our present-day facilities for transportation and communication that without the direct aid of the mechanic and the engineer they could never have become organized in their present form, and if such aid were now withdrawn they would immediately and inevitably lose most of their present distinguishing characteristics.

But why multiply illustration and example? The test is simple, and each may apply it for himself. How far could any one of us go in the customary daily routine of life without dependence directly or indirectly on means or facilities which have been provided by the engineer and the mechanic, working in their raw material—the constructive materials of engineering and the physical energies of nature?

But granted that this is all true, what does it prove? Do we conclude that the engineer and the mechanic are therefore of chief importance in modern society and as factors in modern civilization? By no means. The question is not one of comparison between this and other callings, but of the place and function of the one calling which forms the basis of our present thought. The organization of modern society and the status of our present-day civilization may very properly be compared to a chain with its varied and numerous links, or perhaps still more closely to many interlinking chains as in a piece of woven chain armor. We may imagine such a piece of armor to consist of a number of separate chains, each representing, if you please, one of the broad world activities which have been mentioned above, and which refer each to some one fundamental demand of our modern civilization. But in order to make the mesh of our armor complete we must have, in addition, innumerable link connections between the separate chains or elements, tying and weaving them together into one continuous web or mesh. It is somewhat thus with the function of the engineer and mechanic. It stands indeed in no direct relation to a single fundamental need of humanity or of civilization, such as food, clothing, shelter, instruction, government, amusement, or preservation; but it rather permeates all of these activities singly, and serves its part as well in weaving them together into the fabric of our civilization as we know it today.

Do not think that the function or the place of the engineer and mechanic is thus presented in a boastful spirit. One link of a chain may not say to another, "I am more important than thou." In this sense all are of equal importance. The rupture of one link causes the chain to fail, and so the absence of any one constituent feature of our modern society and civilization would cause it to fall asunder and perish, or, in reaching a new stable condition, to take on some form perhaps entirely unrecognizable from our present-day ideals.

So the engineer and the mechanic, in appreciating the permeating influence and importance of this status in our modern civilization, as we have thus attempted to sketch it, should do so not in pride, but in humble thankfulness that to him has been delivered so important a trust, and with a full realization of the deep obligations and lofty privileges which his position in society entails.

And so, in addressing you as graduates of a technical school, some of whom may be called into immediate activity in practical walks of life and others of whom may pursue still further your work of study and preparation, I would call upon you to realize the importance, the dignity, and the responsibility which inhere in the calling which you have presumably made your choice. Remember the part played in our modern civilization by the physical energies of nature in their manifold forms, and as we have briefly noted them this evening. Remember that mechanical energy in some form enters into almost every activity of which our civilization consists, and remember that it is given to you thus to stand between the energies of nature on the one hand and the needs of our modern civilization on the other, and to liberate, transform, adapt, and use the one in the service of the other. Remember that to fill faithfully and well this station, you need the most intimate acquaintance possible with energy on the one hand and with the constructive materials of engineering on the other. Energy you must know in its varied forms, and the laws of its transformation from one form to another; and in particular among the familiar forms, heat, mechanical work, and electric work. The materials of construction you must know as regards their occurrence in nature and their mechanical properties of value to the mechanic and the engineer. This indicates two broad areas in the activity of the engineer and mechanic, in thus dealing with his two classes of raw material: energy on the one hand, and the constructive materials of engineering on the other. Remember again that we are unable to deal with energy except as it is embodied in matter, and that the many transformations and adaptations which are called for by our civilization at large and by the demands of modern industry in particular, can be carried out only by the aid of engineering structures or mechanisms, cunningly devised by the genius of the designer and constructed by the skill of the builder. This points out again two other broad areas in the activity of the engineer and mechanic, and for which you must also be duly fortified—the design of mechanisms and structures on the one hand, and their construction on the other.

I need scarcely remind you that the designer is called on to use his knowledge of mechanics, of geometry, and of the properties of materials, to combine these with reference to the special energy transformation which he has in view, and then to develop by drawing board processes a geometrical representation of the mechanism or structure suited to the specific purpose. Thus far, however, his work does not constitute a mechanism or a structure, but simply a geometrical ideal of abstraction. It then remains for the builder to carry forward this ideal to realization; to clothe it with the materials of construction and thus to realize the ultimate purpose for which the design was undertaken.

Remember, in brief, that henceforth in the field of engineering and the mechanic arts you are to deal with energy and with matter, and with their use in the service of humanity; and that all the familiarity you can acquire with both of these will be none too much to enable you to deal successfully with the many problems you will meet in the daily practice of your calling.

Remember that upon you, with others in the same calling, will rest the responsibility for the immediate future of our material civilization, and that humanity looks to you for the development and use of the energies of nature in its behalf. But if you are to adapt and use the energies of nature in the service of modern civilization, and more directly as a fundamental factor in modern industry, your study and training must have some special reference likewise to the demands and opportunities in this field of application. Your education and future training in practical life must therefore take on a twofold aspect: that which relates to the fundamental transformations of energy, and that which relates to its use in detail for the needs of modern industry. The former must be fundamentally scientific in character; the latter, operative, economic, industrial, and practical.

Think for a moment on the characteristics of the world-civilization, especially on the material and industrial sides, a short four hundred years ago, when this broad land was newly discovered and colonized from Europe; or, again, two thousand years ago, when Greece and Rome were the dominant powers in the world; and then compare with the present. Without entering into details, the fact is clear and fundamental for our present purpose, that the world's work in these periods, and, in fact, to within a little more than a century, was not done by mechanical energy drawn from sources hidden away by nature, but by the organic energy of living beings—men and domestic animals. If we consider but for a moment the distinctive differences between these two types of civilization, the ancient and the modern, we readily note that these differences spring from the fact that we have pressed forward in these latter days a little further into the secrets of nature; that we have learned to harness her energies to do our work; and that the fabric of our modern civilization thus depends on the existence of such stores of energy ready to our hand, and on our knowing how to harness and to use them.

Remember then I ask you, that this profound change has come about in little more than a century, and that today we enjoy the heritage of those who first pointed the way toward these achievements, and of those who later carried forward these early efforts to the splendid fruition which is ours at the present time.

Remember that you stand today in the place of Savery, Newcomen, Watt, and a host of others, with their developments in the use of steam and the steam engine; of Nasmyth, with his steam hammer; of Stephenson, with his locomotive; of Ericsson, with his screw propeller, and other pioneer achievements; of Morse, with his telegraph; of Kelvin and Field, with the insight into nature and the vision of the future which gave us the trans-ocean cables; of Bell, Gray, and others, with the telephone; of Whitney, with his cotton gin; of McCormick, with his grain reaper; of Howe, with his sewing machine; of Hoe, with his printing press; of Fulton, Stevens, Bessemer, Siemens, Edison, and hosts of others, who have worthily wrought in the past in order that we may enjoy today the comforts of our homes and the pleasures and opportunities of life.

Remember that the mantles of these great men of a former age have now fallen upon your shoulders; that upon you devolves the duty of carrying forward the work of the past and of worthily filling the places of those whose work is done, and into the fruits of whose labors we have entered.

With your eyes turned thus upon the present and the immediate future, and upon your duties in the service of humanity, let me conclude with a word of suggestion regarding the material which the present industrial world demands in its service.

I say nothing further regarding education and technical training. Reference has already been made to the need of study and of training; of study that we may become acquainted with the achievements of the past and with the store of knowledge which has been already acquired, and of training that we may apply this knowledge in the service of humanity to the solution of new problems and to the investigation of new and unknown fields of human activity. All this is taken for granted; but beyond this fundamental requirement, let me add a few characteristics which success in engineering and industrial lines demands today, perhaps, as never before.

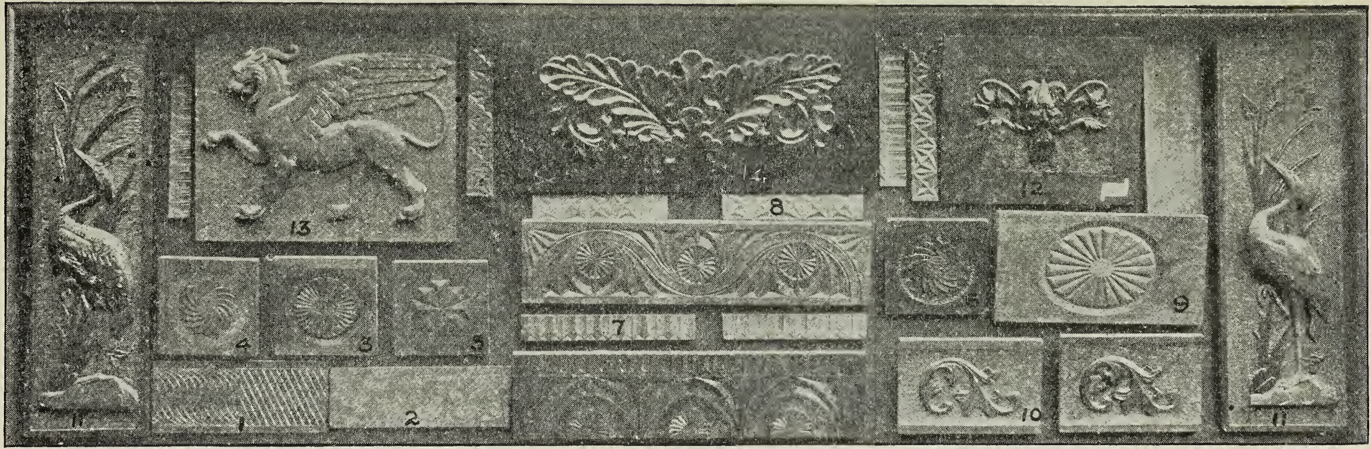
First—Modern conditions in the engineering and industrial world require, as never before, regard to the economy of operation. With the industrial tendencies of modern times, the keenness of competition, and the advance of the economics to the front as a controlling feature in all industrial operations, the increasing importance of this side of the activity of the engineer can no longer be doubted.

Having in view these facts, it seems to follow that the leaders in the industrial world in the immediate future will be, to an increasing extent, men of affairs; men with some capacity and training in the administration and conduct of business and industrial enterprises; men fully alive to the economic and practical aspects of this field of work; men capable not only of transforming and using energy for the ends of industry, but of producing with a given investment of energy the largest practicable output of useful product; men capable not only of doing things, but of doing them in the most efficient and economic manner.

Second—Now, as never before, the conditions of the industrial age demand results. Promissory notes of achievement at some future time are so discounted as to be of little value. And, thus, as never before, the energies of those who are called to this field of activity must be co-ordinated toward the most rapid achievement of the largest result with the smallest initial outlay or investment.

Third—Success in modern engineering and industrial lines calls for a spirit of devotion to the work; the spirit which "carries the message to Garcia," in spite of all obstacles and difficulties; the spirit which knows no defeat and which accepts a check at one point simply as a sign-post pointing to another route; the spirit which prompts to say—not "I don't know," but rather "I'll find out"; the spirit which prompts to the giving of more than is received; of being worth more than the salary paid; the spirit which makes the interests of the employer and the employee at one; in brief, the spirit which will naturally come with the full and deep realization of your responsibilities and privileges, charged as you are with the sacred duty of interpreting the secrets with which nature has guarded her stores of energy, and of transforming, adapting, and bringing these into the service of humanity.

I doubt not that you do realize these responsibilities and privileges, and if anything I may have said shall have the effect of further confirming you in your spirit of loyalty and service in these fields of human activity, I shall feel that the half hour which we have passed together in considering these matters has not been unwisely spent.



WOOD CARVING.

Some of the Examination Papers Set in June, 1904.

ANNUAL EXAMINATION IN STEAM ENGINEERING.

FOURTH YEAR CLASS, MAY 23, 1904.

1. The accompanying diagram was taken with a 40 spring from the high speed engine of the Polytechnic Institute. Assuming that the steam consumed per unit of power as determined from indicator diagrams is 75 per cent. of the actual consumption, it is required to find from this diagram the number of pounds of steam the engine was consuming per I. H. P. per hour.

2. Stroke of engine, 24 inches; initial absolute pressure of steam at cylinder, 100 lbs., but wire-drawing reduces the pressure to 95 lbs. at cut-off. Back pressure, 18 lbs.; cut-off, ¼ stroke; clearance, 10 per cent. Release takes place at 90 per cent. of stroke, and exhaust closes after 75 per cent. of the return stroke is completed. The expansion and compression being hyperbolic, construct the expected indicator diagram, and find the terminal pressure, p_2; the final pressure of compression, p_c; and the mean effective pressure, p_e, the latter by means of ordinates.

3. An engine, 18.5″ x 30″, makes 129 revolutions per minute. The mean effective pressure is 36.6 lbs. per square inch, and the consumption of coal per I. H. P. per hour is 3 lbs. The weight of steam used per stroke is 0.3478 lbs. Find the number of pounds of steam used per I. H. P. per hour; the coal consumption (long tons) per day; the number of pounds of water the boiler must evaporate per pound of coal.

4. An engine is to develop 46 I. H. P. at a piston speed of 625 feet per minute. Absolute steam pressure, 95 lbs.; cut-off, 0.25 stroke; back pressure, 2 lbs. above atmosphere; clearance, 5 per cent. Find the necessary diameter of the cylinder, and, assuming a suitable stroke, determine the revolutions per minute.

5. What are the primary objects in testing engines and boilers? Describe briefly how to weigh the feed water during a test. Trace the course of the steam in its passage through a triple expansion engine and surface condenser until its final return to the boiler.

6. Crank angle at cut-off, 105 degrees; lead angle, 8 degrees; maximum port opening to steam, ⅞ inch. Find by means of a Zeuner diagram, the travel of the valve, the lap, the lead, and the angular advance of the eccentric.

7. What are the necessary attachments to a boiler? The steam pressure in a cylindrical steel boiler is to be maintained at 210 lbs. per square inch. Diameter of shell, 14 ft., and the efficiency of the riveted joint 85 per cent. Using a factor of safety of 4, it is required to find the necessary thickness of shell.

Mechanics.

FOURTH YEAR CLASS—FEBRUARY 1, 1904.

1. Find the magnitude, R, and direction, θ, of the resultant of the three forces, $P = 30$ lbs., $Q = 70$ lbs., $S = 50$ lbs., the angle between P and Q being 56°, and between Q and S, 104°.

2. Forces proportional to 1, $\sqrt{3}$, and 2 act at a point, and are in equilibrium: find the angles between their lines of action.

3. A uniform beam, 5 feet long, weighing 10 lbs., is supported by props at the ends: find where a weight of 30 lbs. must be placed so that the pressures on the two props shall be 15 lbs. and 25 lbs.

4. On a uniform straight lever weighing 5 lbs. and 5 feet in length, weights of 1, 2, 3, 4 lbs. are hung at the distances 1, 2, 3, 4 feet respectively from one end: find the position of the fulcrum on which the whole will rest.

5. A body is supported on an inclined plane by a force parallel to the plane and equal to 1-5 the weight of the body; find the ratio of the height to the base of the plane.

6. A body whose weight is 20 lbs. is just sustained on a rough inclined plane by a horizontal force of 2 lbs., and a force of 10 lbs. along the plane: find the inclination of the plane, the coefficient of friction being 2-5.

7. The rim of a fly-wheel weighs 8 tons, and the mean linear velocity of its mass is 50 feet per second; find how many foot-tons are stored up in it. What must be the increase in velocity if it is desired to store 125 foot-tons additional?

8. The vertical post of a crane is 8 feet high, and the boom, which makes an angle of 30° with the post, is 20 feet long, weighs 0.25 ton, and has a weight of 1 ton suspended from its extremity; find the tension of the tie and the magnitude and direction of the reaction of the thrust on the boom. (A graphical solution of this question counts but two-thirds).

9. A steam engine is required to raise 70 cubic feet of water per minute from a depth of 800 feet. Find how many tons of coal will be required per day of 24 hours, supposing the efficiency of the engine to be 60% and that a pound of coal develops 500,000 units of work.

Find also the number of pounds of coal consumed per I. H. P. per hour.

10. At the bottom of a coal mine, 275 feet deep, there is an iron cage containing 14 cwt. of coal, the cage itself weighing 4 cwt. 109 lbs., and the wire rope that raises it 6 lbs. per yard. Find the work done when the load has been lifted to the surface, and the H.P. of the engine that can do this work in 40 seconds.

11. A lever safety-valve is required to blow off at 70 lbs. per sq. inch. Diameter of valve, 3 inches; weight of valve, 3 lbs.; short arm of lever, 2.5 inches; weight of lever, 11 lbs.; distance of c. of g. of lever from fulcrum, 15 inches. Find the distance at which a cast-iron ball 6 inches in diameter must be placed from the fulcrum, the weight of the ball-hook being 0.6 lb.

12. Find the height of the centre of gravity of a T section from the foot, the top cross-piece being 12 inches wide, 4 inches deep, and the stem 3 feet deep, 3 inches wide. Check by seeing if the moments are equal about a line passing through the section at the height found.

Mechanics of Materials.

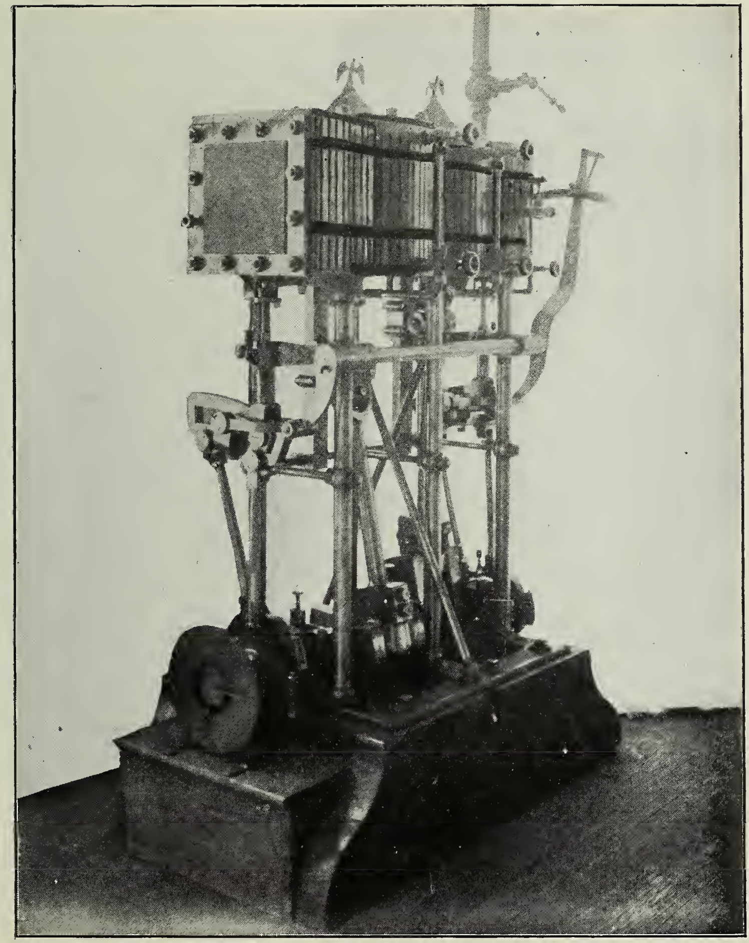
FINAL EXAMINATION, FOURTH YEAR CLASS, MAY 18, 1904.

1. A uniform beam 25 feet in length and weighing 500 lbs., is supported at the ends, and has a concentrated load of 400 lbs. at 18 feet from the left support. Construct the shear and bending-moment diagrams, and find the maximum bending moment and the maximum shear. Length scale, ⅛ inch equal 1 foot. Load scale for bending moments, 1 inch equals 5,000 pounds-feet, and for shear, 1 inch equals 800 pounds.

2. Light 12-inch Cambria I beams of 20 feet span are to support a floor bearing a uniform load of 175 lbs. per square foot. The outermost fibre stress is not to exceed 16,000 lbs. per square inch. At what distance apart should the beams be placed?

3. A hollow cylindrical cast-iron column 14 feet long, is to support a steady load of 142,000 pounds. Assuming its outside diameter to be 8 inches, it is required to determine the necessary thickness of metal.

4. Find the outside and inside diameters of a hollow steel shaft to transmit 3,000 I. H. P. at 200 revolutions per minute, the inside diameter to be 54 per cent. of the outside diameter, the maximum equivalent twisting moment to be taken at 1.5 times the mean, and the unit stress on the outermost fibre not to exceed 10,000 lbs. per square inch. Find also the diameter of a solid shaft to transmit the



COMPOUND ENGINE.

BUILT BY STUDENTS AFTER DESIGN OF THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT.

same power under the same conditions. Prove the equality of strength of the shafts, and show that the hollow shaft is 25 per cent. the lighter.

5. A simple beam 30 feet long weighs 20 lbs. per foot, and overhangs each support 6 feet. It bears a superimposed load of 100 lbs. per foot and of 1,400 lbs. concentrated at a point 3 feet to the right of the middle. Construct the shear diagram to a linear scale of ⅛ inch to the foot, and to a load scale of 1 inch equals 2,000 lbs. Find the bending moment at the dangerous section, and the distances of the points of inflection from the left support.

Materials of Engineering.

FOURTH YEAR CLASS, FEBRUARY 3, 1904.

1. What metals are used in forming alloys suitable for engineering purposes? What names are given the resulting compositions?

2. In the classification of iron and steel, what metals are known as malleable, semi-malleable, and non-malleable?

3. How is the quality of cast-iron affected by the different methods and fuels employed in its reduction? From what source does cast-iron adsorb much carbon? What is the difference in character of cast-iron containing a high percentage of graphitic carbon and that containing a high percentage of combined carbon? What brand of pig-iron is much used in castings requiring the maximum of strength?

4. How can cast-iron be made partly malleable? Sketch and give dimensions of specimens of cast-iron for compression, transverse, and tensile tests. Give, as a result of your experience in testing, the average crushing, transverse, and tensile strengths of cast-iron in pounds per square inch.

5. By what process is the most of wrought-iron produced? What element is nearly eliminated from the iron by this process? State some of the properties of wrought-iron. When testing wrought-iron, what have you found to be the tensile strength per square inch, and the percentage of elongation in 8 inches?

6. By what process is wrought-iron converted into the high-grade steel known as tool steel? What is the process for converting cast-iron into mild, or structural, steel? Which of the two methods for converting cast-iron into structural steel is preferable when the material is to be used in the construction of boilers and shafting? Explain what is meant: (*a*) by the basic process; (*b*) by the acid process.

7. What impurities, other than carbon, are contained in steel? How are the strength and ductility of steel affected by the amount of carbon it contains? What is semi-steel?

8. Describe the different physical tests for structural steel. Make a sketch showing the forms and dimensions of specimens used for testing steel for boiler plates and for steel forgings. Given a forged steel specimen finished to ¾″ diameter and 2″ between centre dots; how would you proceed with the test?

Differential Calculus.

FOURTH YEAR CLASS—FEBRUARY 15, 1904.

(Ten of the twelve questions are required.)

1. Give the definition and an illustration of a derivative.

2. Given $y = \frac{e^x}{1+e^x}$ find $\frac{dy}{dx}$.

3. Derive the formula for the differentiation of $\tan^{-1} u$.

4. Expand $\cos (x + a)$ in a power series of a.

5. Evaluate $\frac{\log (1+x)}{x}$ when $x = \infty$.

6. An open tank is constructed with a square base and vertical sides. Show that the area of the entire inner surface will be least if the depth is half the width.

7. A circular plate of metal expands so that its diameter increases uniformly at the rate of 0.002 of an inch per second; at what rate is the surface increasing when the diameter is 5 inches?

8. Express $\frac{d^2y}{dx^2}$ in terms of $\frac{dx}{dy}$ and $\frac{d^2x}{dy^2}$;

9. Find the intercepts made upon the axes by the tangent at (x_1, y_1) to the curve $\sqrt{x} + \sqrt{y} = a$; and show that their sum is constant.

10. Given $\rho = \cos \theta$, find $\frac{ds}{d\theta}$.

11. Examine the curve $y\ (a^4 - b^4) = x (x - a)^4 - xb^4$ for a point of inflection.

12. Explain what is meant by the measure of curvature at a given point. Derive the formula.

Integral Calculus.

FOURTH YEAR CLASS—MAY 25, 1904.

(Ten of the twelve questions are required.)

1. Find the equation of the curve in which, for any point, the length of the subtangent varies as the square of the length of the ordinate.

2. Integrate $(12x^2-12xy+3y^4-42bx^6)\,dx+(12xy^3-6x^2-35ay^4)\,dy$.

3. Integrate $(2x-2)\,(x^2-2x+5)\cos(x^2-2x+5)\,dx$.

4. Find the total area included between thecurve $y=x^3$ and the line $y=4x$.

5. Find the equation of the curve in which, for any point, the length of the polar substangent is proportional to the length of the radius vector.

6. Find the areas included between the parabolas $y^2=4ax$ and $x^2=4ay$.

7. $$\int_a^{2a}\frac{\sqrt{x^2-a^2}}{x^4}\,dx.$$

8. Derive a formula for the integration of $x^{M}\left(a+bx^{N}\right)^{P}dx$.

9. $$\int_0^{\frac{\pi}{2}}\int_a^b\int_0^{\pi}\sin x\,(dx)^3.$$

10. Find the volume of a right conoid with an altitude h and a circular base of radius b.

11. Find the mean length of the ordinates of a semi-circle of radius a, the ordinates being drawn at equidistant intervals on the diameter.

12. Find the radius of gyration of a uniform circular cylinder about its diameter.

Examination in Electricity.

FOURTH YEAR CLASS—MAY 27, 1904.

1. Describe the series arc lamp. How can a ground on a series line be detected? Describe a method of locating the ground.

2. Sketch two generators with their shunt and series coils and show the connections to an equalizer. Why is the equalizer used?

3. What is the advantage of distributing 20 horsepower at 1,000 volts as compared with a distribution at 220 volts, the distance being ½ mile and the loss being limited to 2 per cent?

4. How many lamps may be connected on a No. 4 wire, so that the drop will not exceed 2 volts in 200 feet? Lamps require 60 watts and the electromotive force is 110 volts.

5. Give diagram for determining the insulation resistance between the conductors and the ground on a parallel line. What would be the readings if the generator gave 220 volts and the insulation resistance were 500,000 ohms?

6. Describe how the feeders are connected with the trolley on a railway line. Give a sketch of a lightning arrester, with magnetic blow-out, connected in the line.

7. What brake force will be required to stop an eight ton car within 200 feet, if car be running at a rate of 20 miles an hour, coefficient of friction of brake shoes being 20 per cent? Name the connections made at the four important running points of a G. E. controller.

8. How can a single phase alternating current motor be started? Why are alternating currents preferred to the direct? What is meant by the power factor of a motor?

9. Sketch four pole-pieces of a three-phase alternator, with the coils under them, and show by diagram the two methods of connecting the sets of coils. Which method gives the higher electromotive force?

10. Illustrate the connections of an inter-communicating system of telephones and state why the hand switch was abandoned. Explain the difference between the local current through the transmitter and the line current.

Examination in Chemistry.

FOURTH YEAR CLASS—MAY 16, 1904.

1. Give tests for copper, iron, magnesium, nitrates, and iodides.

2. Complete the following equations, supplying the proper coefficients:

$HgCl_2+Cu=$

$Ba(NO_3)_2+H_2SO_4=$

$CoS+HCl+HNO_3=$

$Pb(NO_3)_2+HCl=$

$CaCO_3+HC_2H_3O_2=$

3. Calculate the number of cubic centimeters of hydrochloric acid required for a normal solution, the acid used being 40% and its specific gravity 1.2.

4. Calculate the quantity of salt which must be dissolved in a liter of water to make a solution that will precipitate .02 gram of silver to 1 cubic centimeter of the standard. What per cent. of silver is in a solution which requires 100 cubic centimeters of the above standard solution to precipitate the silver in 20 cubic centimeters?

5. Describe the principal points of an analysis of steel for carbon,

giving sketch illustrating the combustion, purifying, and absorbing tubes. Should the weight of the absorbing train increase 0.6 gram for 10 grams of steel, what would be the per cent. of carbon indicated?

6. Iron is to be tested for per cent. of phosphorus. Considering the precipitate of phosphorus with molybdic acid and ammonia as $(NH_4)_3(MoO_3)_{11}PO_4+9H_2O$, what amount of iron should be used so that the weight of the precipitate would be also the per cent. of phosphorus?

7. Qualitative analysis in laboratory of a mixture of two soluble powders.

8. Quantitative analysis in laboratory of a solution for per cent. of iron.

Steam Engineering.

THIRD YEAR CLASS, MAY 25, 1904.

1. What does the indicator diagram primarily show? Draw what you would consider a good diagram for a medium speed engine, naming the different parts of the diagram. Show by dotted lines defects that would cause deviations from this ideal card. What two conditions would cause a looped diagram, and how is the loop taken into account in finding the mean effective pressure?

2. Make eight sketches of the important positions of a plain slide valve, showing the ports and piston, during one stroke of an engine, the dimensions being as follows: Stroke of engine, 10″; width of steam ports, 1″; width of exhaust port, 3″; thickness of metal between steam and exhaust ports, ¾″; steam lap, ⅝″; exhaust lap, ¼″; steam lead, ⅛″; travel of valve, 3″. Scale, 3″=1′.

3. A simple Corliss engine, 16″x30″, has a clearance of 5%. The initial steam pressure is 75 lbs. per gauge, with cut-off at ¼ stroke. Find the ratio of expansion and the terminal pressure. Prove the accuracy of your work by showing that the pounds of steam sent into the engine will fill finally the whole cylinder and clearance at the end of the stroke. The steam is assumed to be saturated and the specific volume may be found by the formula.

4. Find the position of the piston, measured from each end of the stroke, in example 3 when the crank makes an angle of 120° with the head dead centre, if the crank-connecting-rod ratio is 1 : 6.

5. In making a test of the quality of steam, the barrel of the calorimeter contained 160 lbs. of water at a temperature of 60°. 8.5 lbs. of the moist steam at a pressure of 75 lbs. per gauge, with the corresponding temperature of 319.8°, were blown into the barrel, after which the temperature of the mixture was found to be 117°.

Find the dryness fraction of the steam. If the temperature of the feed water was raised to 182° by the use of an exhaust steam feed-water heater, find the heat necessary to generate a pound of the moist steam.

6. Find the I. H. P. from the given indicator diagram taken from a 16″x30″ Corliss engine, making 80 R. P. M. Scale of diagram, 40. While the card was being taken the B. H. P. was found to be 94. Find the mechanical efficiency.

7. During a twelve hour test of the engine of Question 6, and of a return fire-tubular boiler, 31,500 lbs. of water were fed to the boiler, and 3,600 lbs. of coal were burned; 954 lbs. of steam were used by the feed pump and other accessories; 695 lbs. of water were separated from the moist steam before it entered the engine; and six calorimeter tests were made with the average results as in Example 5. From tests of the coal, it was found that it contained 3% of moisture and 8% of ash. Assume the average value of the I. H. P. to be the same as found from the indicator diagram of Example 6. Find:—Pounds of water evaporated per lb. of coal; equivalent evaporation per lb. of dry combustible from and at 212°; pounds of steam per I. H. P. per hour; and pounds of coal per I. H. P. per hour. Is the performance of the engine, of the boiler, and of the engine and boiler combined, good, fair, or poor?

Plane Trigonometry.

THIRD YEAR CLASS—FEBRUARY 17, 1904.

1. Give the values of the six trigonometric functions of 0°, 30°, 45°, 60°, 90°, 120°, 135°, 150° and 180°.

2. Determine x if $2 \cos x + \sec x = 3$.

3. In a unit circle what is the length of a chord corresponding to an angle of 45° at the centre?

4. Derive the formulas for $\cos\frac{1}{2}A$ and $\sin\frac{1}{2}A$.

5. Prove the law of cosines.

6. What is the base of the system when $\log 0.008 = -1.5$?

7. Find the area of a parallelogram if its diagonals are 2 and 3 respectively, and intersect each other at an angle of 30° 40′ 50″.

8. Solve the triangle, given $a = 48.76$, $b = 62.92$, $c = 80.24$.

9. The area of a right triangle is 6 and the sum of the three sides is 12; solve the triangle.

Prove that $\cos(2 \sin^{-1} x) = 1 - 2x^2$.

Spherical Trigonometry and Surveying.

THIRD YEAR CLASS—MAY 27, 1904.

1. In a right spherical triangle prove $\tan^2 \frac{B}{2} = \frac{\sin (c-a)}{\sin (c+a)}$.

2. Find b, A and B in a right spherical triangle when $c=55° \ 9' \ 32''$ and $a=22° \ 15' \ 7''$.

3. In an oblique spherical triangle prove

$$\cos a = \cos b \cos c + \sin b \sin c \cos A.$$

4. Given $b=63° \ 15' \ 12''$, $c=47° \ 42' \ 1''$, $A=59° \ 4' \ 25''$; determine B, C and a.

5. Explain fully how to measure across a body of water, using only a chain.

6. Make a sketch of a portion of a leveling rod, showing the position of the vernier when the reading is 4.873 feet.

7. Reading angles, making use of the vernier.

8, 9, 10. Compute the area and make a plot from the following notes:

STATIONS.	BEARINGS.	DISTANCES.
1	S. 20°45′ E.	13.11 chains.
2	N.48°15′ E.	13.62 chains.
3	N.43°45′ W.	4.73 chains.
4	N.45°15′ W.	4.75 chains.
5	S. 51°30′ W.	2.53 chains.
6	S. 72°30′ W.	6.56 chains.

Analytic Geometry.

THIRD YEAR CLASS—MAY 20, 1904.

(Ten of the twelve questions are required.)

1. One end of a line, whose length is 15, is the point $(-4, 8)$ and the ordinate of the other end is 3. What is its abscissa?

2. A point moves so that its distance from the axis of X is half its distance from the origin; find the equation of its locus and discuss it.

3. Derive the Symmetrical Equation of the straight line.

4. Find the equation of the tangent to the circle $x^2+y^2=r^2$ in terms of its slope.

5. Derive the four forms of the polar equation of the circle.

6. Transform the equation $x^2-y^2+6=0$ by turning the axes through 45°.

7. Derive the equation of the diameter of the parabola $y^2=4px$, $y=mx+b$ being a chord of the diameter.

8. What is the ratio of the two axes if the centre and the foci of an ellipse divide the major axis into four equal parts?

9. Discuss the equation of the hyperbola.

10. Show that the sum of the squares of any pair of semi-conjugate diameters of an ellipse is equal to the sum of the squares of its semi-axes.

11. Derive the equation of an hyperbola referred to its asymptotes as axes of coördinates.

12. Find the equation of the Witch of Agnesi.

Literature. Third Year Class.

Paper Set in February, 1904.

I.—What is the source of the story of "Macbeth," and what changes did Shakespeare make in dramatizing it?

II.—Tell in detail how Lady Macbeth overcame Macbeth's scruples against murdering Duncan.

III.—Trace Macduff throughout the play.

IV.—Why does Macbeth conceal from Lady Macbeth his intention to murder Banquo?

V.—What is the dramatic significance of the first words spoken by Macbeth in the play? What is the dramatic purpose of the conversation between Lady Macduff and her son?

VI.—Define the following terms, illustrating your definitions by referring to incidents, situations, or circumstances in the play: Complicating Circumstances; Resolving Circumstances; Climax; Catastrophe.

VII.—Explain, by comment or paraphrase, the following passages:

(a) "There's no art
To find the mind's construction in the face."

(b) "Or memorize another Golgotha."

(c) "The near in blood, the nearer bloody."

(d) "To all and him we thirst, and all to all."

(e) "Ere to black Hecate's summons,
The shard-borne beetle with his drowsy hums
Hath rung night's yawning peal . . . ."

VIII.—Account for the fact that our greatest dramas were written in the Elizabethan Age.

IX.—Discuss, in a theme of not less than 300 words, one or more of the general characteristics of Shakespeare's plays.

Paper Set in June, 1904.

I.—Compare L'Allegro and Il Penseroso as companion poems, showing in some detail the correspondence in structure and the difference in subject-matter and mood.

II.—

> "Or whether thou, to our moist vows denied,
> Sleep'st by the fable of Bellerus old,
> Where the great Vision of the guarded Mount
> Looks toward Namancos and Bayona's hold."

Locate this quotation and explain the allusions.

III.—Discuss the difference between the Mask and the Drama.

IV.—Explain or comment upon the meaning of the following words or phrases:

(a) *Once more*, in "Yet once more, O ye laurels——;" (b) buxom; (c) Friar's lantern; (d) weeds of peace; (e) massy proof; (f) curfew; (g) storied windows richly dight; (h) ruth; (i) darkest grain.

V.—Answer (a) or (b): (a) Account for the fact that Burke never attained a Cabinet position. (b) Outside the "Statement of Facts" in the "Conciliation."

VI.—In the early part of the speech, what reasons does Burke allege against the employment of force? Had he chosen to place these reasons elsewhere, what would have been the proper place for them? Why?

VII.—Compare, as literary periods, the first forty years of the eighteenth century and the first forty years of the nineteenth.

Specimen Entrance Examination Papers set for Pupils other than those entering from the Grammar Schools.

Spelling and Penmanship.

Writing from dictation a paragraph or two of some standard text—Irving's Rip Van Winkle or Bancroft's United States History.

Grammar.

I.—Use each part of speech in a different sentence, indicating the part of speech used in each sentence by underscoring and naming it.

II.—Define and give an example of a simple sentence, of a complex sentence, and of a compound sentence.

III.—Parse the underscored words in the following sentence:

> "By not heeding the counsels of our elders, how often do we lose what we should gain."

IV.—Analyze the following sentence:

> "If we send the sailors a message in time, they will help us when the savages attack us."

V.—Write sentences illustrating the correct use of any perfect tense of the following verbs: sit, set, seat, lie, lay, write, go.

Composition.

The subject set is a description of some well-known place or object, or an account of some historical event.

United States History.

I.—What country was each of the following explorers serving when he came to America, and what territory did he discover or explore: Columbus, De Soto, Drake, Cartier.

II.—Name the principal causes and the principal results of the French and Indian War.

III.—State several causes of the Revolutionary War.

IV.—What were the "Articles of Confederation," and why, and by what, were they superseded?

V.—What is meant by "The Missouri Compromise?"

VI.—Give a short account of the "Nullification" incident.

VII.—What was the most important result of the Mexican War?

VIII.—Name the principal causes of the Civil War. Who commanded on each side at Gettysburg? Why was the battle of Gettysburg so important?

IX.—What reason did the United States assign for going to war with Spain in 1898? What territory did the United States acquire as a result of that war?

Arithmetic.

1. An alloy is composed of 3½ parts of copper and 2⅓ parts of zinc; what is the percentage of each metal in this alloy?

2. Find the proceeds of a note for $625.32 due in 60 days, at 5% interest, dated August 1, 1904, and discounted at bank September 21, 1904, at 6%.

3. Find the cost of paving with brick, 8 inches by 4 inches, a walk 3 feet wide around a rectangular court 20 feet by 18 yards, if the brick cost $12.37½ per M.

4. A firm sold an engine for $7,050, thereby losing 6%; for what should it have been sold to gain 12%.

5. A 50-foot ladder is placed 10 feet from the base of a wall. At what height will its top touch the wall?

Algebra.

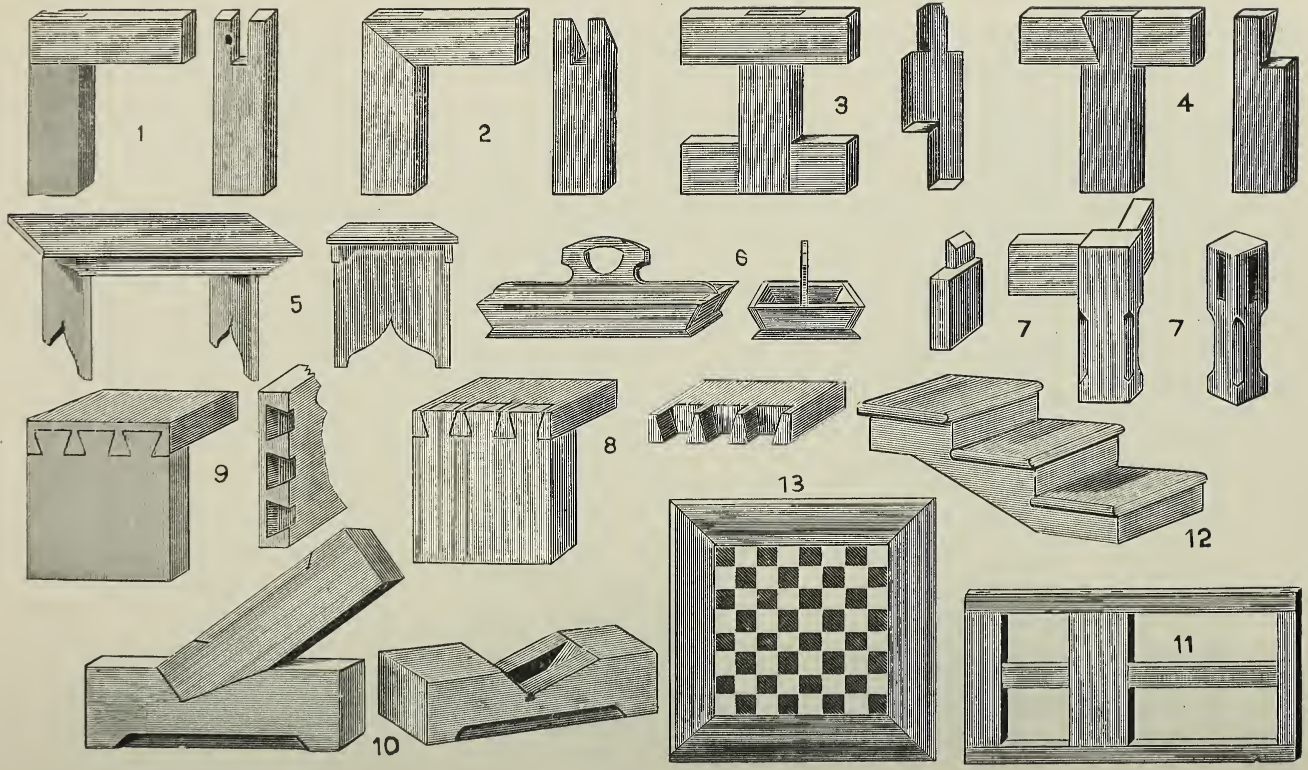
1. Find the L. C. M. of x^2-4a^2, $x^3-3x^2a+2xa^2$, and x^3+8a^3.

2. Simplify $\left[(a^2-x^2) \div (\frac{1}{x}-\frac{1}{a})\right]-\left[(a^2-x^2) \div (\frac{1}{x}+\frac{1}{a})\right]$.

3. Given $\frac{2x+1}{5}-\frac{3y+2}{7}=2y-x$, $\frac{3x-1}{4}+\frac{7y+2}{6}=2x-y$, find the values of x and y.

4. The circumference of the hind wheel of a carriage exceeds that of the front wheel by 4 feet. If the front wheel makes the same number of revolutions in running 400 yards that the hind wheel makes in running 500 yards, what is the diameter of each wheel?

5. Solve the equation $\frac{5x-1}{x+3}+\frac{7x^2-106}{8(x^2-9)}=-\frac{1}{8}$.



CARPENTRY.

Catalogue of Students.

(Corrected to December 1, 1904.)

FOURTH YEAR—A CLASS—31 MEMBERS.

Chester A. A. Albrecht,
James B. Arthur,
Joseph Bowes, Jr.,
Andrew K. Brumbaugh,
Edward C. Cromwell,
John W. Dorsey, Jr.,
Charles A. Edel,
Frank P. Fifer,
Emanuel Fritz,
George Gittelsohn,
J. Lyell Gressitt,
Richard G. Harris,
Edward J. Hecker,
John J. Hills,
Benjamin F. Hoffacker,
Harry V. D. Hunt,
H. Godfrey Jones,
Charles A. Langrall,
Daniel J. Leary,
Samuel May,
John L. Mosher,
Robert G. Pangborn,
Massimo Pisani, Jr.,
Leon Small,
Oscar E. Smith,
Marion Steinberger,
Harry DeG. Thurlow,
Harry Waldorf,
Edwin L. Willson,
Louis A. Witte,
Alexander H. Woollen.

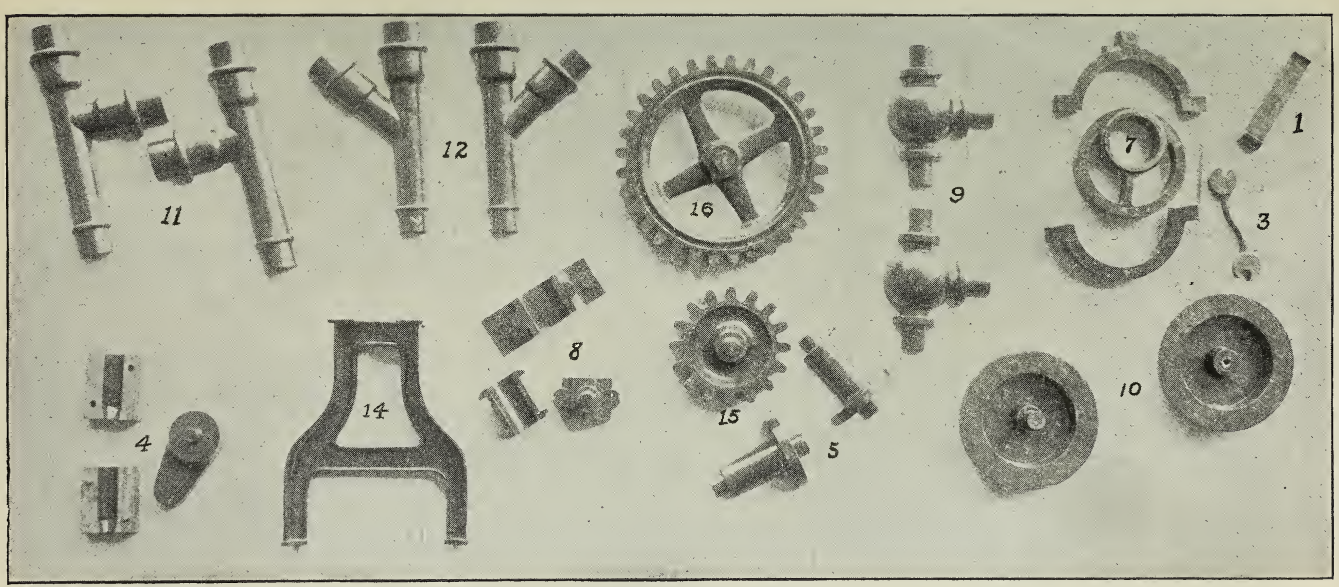
THIRD YEAR—B CLASS—78 MEMBERS.

H. Roy Anderson,
Moses Appel,
Theodore H. Ascherfeld,
Walter K. Bachrach,
Harry C. Becker,
Isadore Behrman,
Hawley Bittle,
J. Ralph Bolgiano,
William Wallace Boyd,
John Oliver Bristow,
Charles A. Butzler,
G. Herman Carl,
Willis B. Clemmitt,
Louis Cunningham,
E. Rowland Dawson,
Charles H. Dorsey,
George Erck,
Harry C. Fink,
Edwin Friese,
Otto A. Geumann,
Edwin B. Gilmour,
Hiram R. Gray,
William Greenfeld,
John R. Guttmann,
John R. Haswell,
Horace K. Hayden,
E. Kenneth Hebden,
Charles W. Henderson,
George W. Henthorn, Jr.,
Robert Q. Herring,
Harry Lee Hess,
George F. Heubeck,

Ralph Holbrook,
Allen L. Justus,
Andrew C. Kemler,
Walter K. Knapp,
Charles C. Krausse,
Charles P. Kuenne,
Howard G. Lanahan,
George F. Lehmann,
Frank T. Leilich,
Harold M. Lewis,
Bernard A. McAbee,
J. Kilby McGrath,
Jerome N. Maisel,
George Foster Maynard,
Carl Frederick Meyer,
Joseph V. Michael,
Lawrence G. Miller,
Sidney T. Mitchell,
Harry Murray,
John C. Newman,
Ferdinand Oppenheimer,
John G. Pertsch, Jr.,
Lewis N. Porter,
Charles J. Rasch,
John T. Ridgely,
Henry F. Robb,
Ernest Rodemeyer,
Arthur S. Scharnagl,
John C. Schirmer,
Louis M. Schneider,
Harry C. Siegel,
Edward K. Stembridge,
David B. Stewart, Jr.,
Levin H. Stewart,
Israel Stolberg,
Frank Suman,
Carroll E. Tauszky,
Nicholas C. Thalheimer,
T. Leonard Walter,
Raymond M. Weaver,
George F. Wennagel,
George Frederick Wieghardt,
Philip H. Williamson,
Walter Bruce Wills,
R. Horatio Wright,
E. Pinkney Wroth.

SECOND YEAR—C CLASS—106 MEMBERS.

Benjamin H. Aires,
Ludwig Aull,
Emil G. Bauersfeld,
Raymond M. Bealer.
James C. Beatty,
Allen C. Beetham,
Alvin M. Bland,
Gustav Bornscheuer,
Walter C. Bowen,
C. Clarence Boyd,
J. Daniel Brendel,
Harry W. Brodie,
Wilbur L. Brooks,
John N. Childs,
J. Samuel Chiveral,
Frank E. Cole,
J. Garrett Crane,
N. Wright Crowder,
Joseph W. Cushing,
Percy Davenport,
Wilmer A. Dehuff,
C. Lehman Downs,
Howard A. Essig,
Herbert S. Fairbank,
Clarence M. Fankhanel,
F. Donald Fenhagen,
H. Walter Ganster,
William C. Getz,
Arthur P. Goetzke,
James R. Green,
C. Edmund Grimes,
Henry P. Gundlach,
G. Herman Guttmann,
R. Milton Hall,
L. Allison Harden,
Carroll R. Harding,



PATTERN WORK.

Jesse G. Harris,
William Hartman,
George G. Hayden,
Bertram E. Heinz,
Guy L. Hess,
F. Merrill Hildebrandt,
George W. Hoffman,
E. Everett Hurdle, Jr.,
Fernando Janer,
Harry B. Joyce,
Laurence A. Kahn,
C. Frederick Kammerer,
John P. Kenney,
M. Rock Kiefer,
MacKendree Kimberly,
Carl Klingelhoefer,
Ernest F. Knabe,
Donald R. Knox,
William H. Krueger, Jr.,
Frederick W. Landwehr,
George M. Lawrence,
Frank H. McCormick,
Newell F. McDorman,
Louis L. McLanahan,
Louis L. McLaughlin,
Laurence F. Magness,
Joseph C. Manning,
Charles A. Mason,
Samuel J. Mealy,
August Mencken,
Richard C. Meyer,
Andrew Miedwig,
Charles E. Mitchell,
Serafin M. Montesinos,
George T. Mumma,
Bernard Munter, Jr.,
Marcus Newhoff,
Samuel P. Nixdorf,
Arthur Norden,
Edwin Herman Nordmann,
Robert E. Palle,
G. Herbert Pohl,
Robert Burns Pumphrey,
George F. Quast,
Charles J. Ritterhoff,
Henry A. Roben,
Edwin Rolker,
George H. Schlutter,
Frederick E. Schnepfe,
Arthur H. Schultz, Jr.,
Nelson Schuster,
Emil Sedlacek,
Frederick B. T. Siems,
V. Bernard Siems,
Charles Silver,
Harry P. Struven,
Samuel P. Tapman, Jr.,
Fraser G. Thatcher,
Albert L. Thomas,
Franklin L. S. Walter,
Thomas H. Webster, Jr.,
Walter Wellmer,
W. Wanton Wheeler,
Bernard Wich,
Edgar F. Wiencke,
R. Mason Wilhelm,
L. Barton Wilson, Jr.,
Jerome B. Wolf,
Charles E. Woollen,
Julius Zieget.

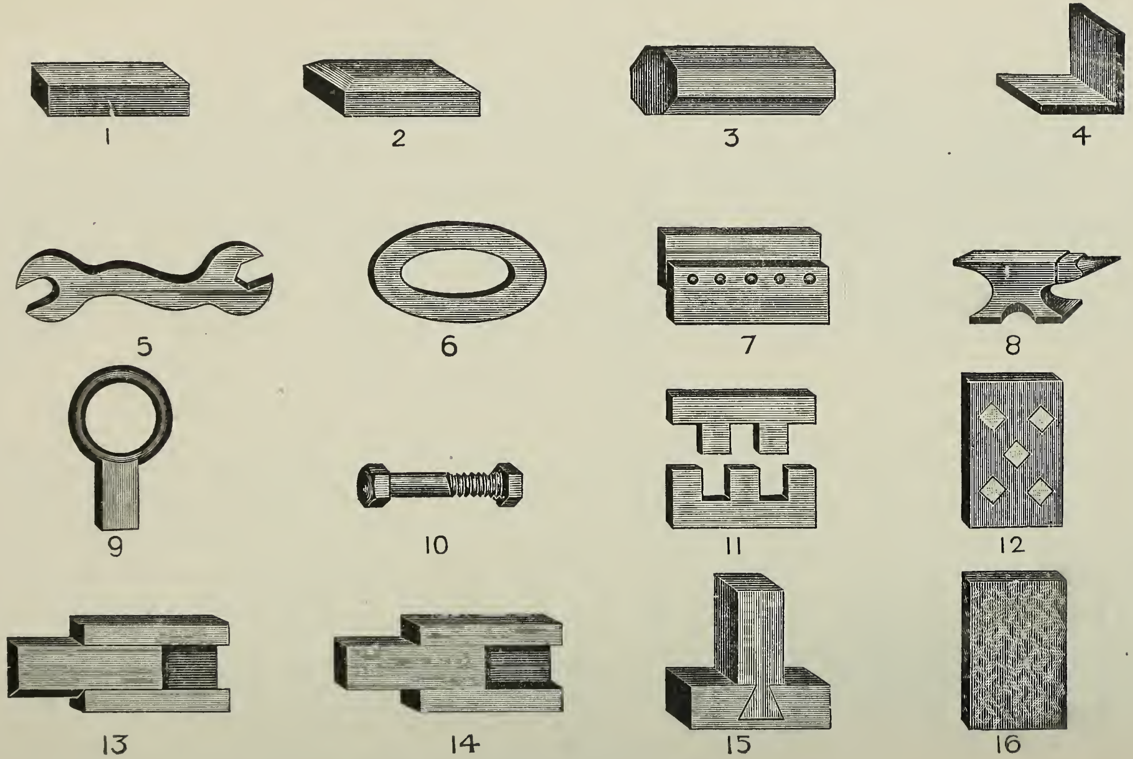
FIRST YEAR—D CLASS—235 MEMBERS.

Harold Abrahams,
Melvyn Abrahams,
Otto E. Adams,
Floyd Owens Anderson,
Gelston Hills Armstrong,
Harry C. Baker,
Harry Christian Ball,
Alvin S. Beauchamp,
Harry C. Becker,
Frank Beehler,
Howard Vernon Bell,
Philip Cecil Belt,
Cullum Stewart Benson,
Sylvan Binswanger,

Harry Lawson Black,
William M. Black,
Bernard Bockelman,
George Boeckel,
Clarence P. Bolgiano,
Gilbert F. Bolgiano,
Ralph C. Bolgiano,
Lazarus Book,
Arthur Watson Bordley,
Joseph Leon Bozman,
John Howard Brown,
Raymond Christopher Bryan,
Charles H. Buck, Jr.,
Joseph D. Bullock,
James H. Busick,
Maurice Cassard Butler,
Nathan R. Butler, Jr.
Walter Still Byrne,
Joseph Anthony Callahan,
James R. Carroll,
Dorrance E. Casey,
Frank J. Casey,
George J. Cherry,
Noble C. Clary,
William James Cleaver,
William Gardner Coffin,
Robert Charles Cole,
William Carroll Comegys,
Albert F. Condon,
Thomas Duffield Conn,
Daniel W. Conway,
William Harrison Cook,
Raymond C. Covey,
Josias Marion Creamer,
Edmund Dantis Cutino,
Franklin Davis,
John Snyder Delano,
Robert Elmer Demuth,
Otis Dewlin,
Arturo Diaz,
John Clarence Dickerson,
George Kuhst Drexel,
Howard T. Dyott,
Raymond G. Ehrman,
William Henry Eichner,
Warner Bernard Elliott,
James Francis Fewster, Jr.,
Frank Fisher, Jr.,
Emil Victor Forthuber,
Harry Phillips Fowler,
George Frey,
Howard Frisch,
Austen Gailey,
Horatio Nelson Gambrill, Jr.,
John L. Gardner,
MacDonald Garrettson,
James Thomas Garrity,
Christian Rudolph Garthe,
George Stewart Giles,
Preston B. Gochnauer,
Harry P. Godman,
Frank Goldenberg,
Eugene Graham,
Thomas M. Green,
T. Douglas Gresham,
Herbert Griffin.
N. Bailey Grove,
William Conrad Haesloop,
Royston Beverly Hall,
Charles Anthony Hanzlik,
Joseph Edward Harrison, Jr.,
George Richard Hartley,
Reuben M. Harvey,
Adrian E. Hawxhurst,
Walter Louis Heathcote,
Fred. Henry N. Heemann,
Walter Frednan Heise,
Edward B. Herrmann,
Archbald Appleton Hess,
Harry Clair Hess,
Harry Wright Hill,
Walter Irvin Hiltz,
Milton August Hodes,
Abraham A. Hollander,
Henry J. Horn,
Raymond H. Hoskins
William A. Hubbard,
Charles W. Huegelmeyer,
Harry E. Hutchinson,
Henry Arad Israel,
Arthur S. Jackson,
Adam William Jahn,

Manuel Janer,
Henry Janney,
George Roy Johnston,
Arthur J. Johnstone,
Charles R. Justi,
Charles F. Kaesemeyer,
Benjamin Kann,
Carl E. Kauffmann,
Clarence Hirsh Kaufman,
Lewis Kaufman,
Thomas Malcolm Kenny,
Mason H. Kornmann,
Albert G. Krumm,
Charles Howard Lambdin,
Louis E. Lamborn,
Lawrence R. Laroque,
Fayette M. Latham,
George R. I. Lathroum,
Walter E. Lee,
Andrew Howlett Lemmon,
Frederick Wm. Lieberknecht,
Thomas M. Linthicum,
Robert J. Lock,
William Wallace Lushbaugh,
Edward James McCall,
George Henry McClelland,
William McDermott,
Francis J. McQuade, Jr.,
Samuel Ernest McQueen,
Thomas Nicholas Manning,
Edgar Markel,
Harper Marlow,
Irving B. Martin,
William James Mason,
Thomas Mayer, Jr.,
Ridgaway Rudisill Merryman,
Thomas B. Meushaw,
H. Osborne Michael,
Harry V. Miller,
Henry Herman Miller,
Milton George Miller,
Weber E. Miller,
Howard Edmund Mitchell,
James F. Murphy,
Clarence Nagle,
Edwin Warfield Nelson,
Arthur B. Nicherson,
Frederick Charles Nordhoff,
John Nuffer,
James Henry O'Connell,
Louis Krebs Owen,
John Robert Owens,
Walter D. Pacy,
William George Parkhurst,
Sterrett H. Parks,
Walter F. Perkins,
William H. Pistel,
Allen H. Potts,
Ferdinand A. Pramschüfer,
Ernest O. Preston,
Mitchell Price,
Frederick Lloyd Purdy,
Roland Webster Quandt,
James Percy Ray,
Frank Reed,
Norman Reinicker,
Raymond Henry Reisenweber,
Herbert Benson Reynolds,
Wwaltf Rhodes,
Norman Francis Rigor,
William Rogan,
Martin A. Rohde,
Paul Rosenthal,
Charles Daniel Sapp,
William S. Saunders,
Gustav W. Schindhelm,
Raymond Schlegel,
Christian Schluderberg,
William Henry Schneider,
John Edward Schorr,
Othello Henry Schroedl,
Alexander P. Schumann,
Arthur G. Schuster,
Louis C. Schwartz,
Walter S. Seaman,
Anthony Sedlacek,
William David Shilling,
John Leon Shipley,
Frank Ellis Shorey,
Harry Siegel,

Otto Sima,
A. Albert Slusky,
Irvin Smith,
Charles A. Sneider,
Carlos A. Soler,
Howard Solloway,
Leopold E. Spieldock,
Benjamin F. Starr,
Reginald Stembridge,
Harry E. Steuart,
William Alvin Stutt,
Milton David Swartz,
Reuben H. Tall,
William F. Tapking, Jr.,
Murrill Mitchell Thomas,
Francis Jordan Thomsen,
William A. J. Tjarks,
Walter M. Troll,
Robert Benson Turner,
Joseph Varholy,
Carl Virgin, Jr.,
Henry Vogt,
Richard Andrew Wagner,
Arthur Waldschmidt,
Romaine G. Waltenberg,
Carl Cecil S. Walter,
Frank T. Weaver,
Raymond C. Webber,
E. Hyde Weedon, Jr.,
Stewart Ijams Whitmarsh,
Herman August Wieghardt,
John F. Wienhold,
Joseph Herbert Wilhelm,
Benjamin F. Williams, Jr.,
Craig McM. Wills,
Leland F. Wilson,
Albert F. Witte,
Martin Wright,
Frederick A. Zscheuschler.



VISE WORK.

Class Organizations.

FOUR YEAR CLASS OF '05.

President	J. Lyell Gressitt.
Vice-President	Edwin L. Willson.
Secretary	Chester A. A. Albrecht.
Treasurer	James B. Arthur.

CLASS OF '06.

President	Sidney D. Mitchell.
Vice-President	John C. Newman.
Secretary	Allen L. Justus.
Treasurer	Raymond M. Weaver.

CLASS OF '07.

President	Harry P. Struven.
Vice-President	Guy L. Hess.
Secretary	Charles E. Mitchell.
Treasurer	Frank H. McCormick.

CLASS OF '08.

President	Samuel E. McQueen.
Vice-President	Walter F. Heise.
Secretary	Andrew H. Lemmon.
Treasurer	

Literary Societies.

THE "LOWELL."

President	Chester A. A. Albrecht, '05.
Vice-President	Marion Steinberger, '05.
Secretary	Raymond M. Weaver, '06.
Treasurer	John G. Pertsch, Jr., '06.
Sergeant-at-Arms	Frank Suman, '06.
Executive Committee	Harold M. Lewis, '06. George F. Wieghardt, '06. Chester A. A. Albrecht, '05, *Ex-Officio.*

THE "POE."

President	Ralph Holbrook, '06.
Vice-President	Charles H. Dorsey, '06.
Secretary	Robert Q. Herring, '06.
Treasurer	Julius Zieget, '07.
Sergeant-at-Arms	Serafin M. Montesinos, '07.
Executive Committee	R. Horatio Wright, '06. Ralph Holbrook, '06. William C. Getz, '07.

Football.

The football season of 1904 was the most successful in the history of the Institute. Of eight games played, four were won and four lost.

The line-up of the team was:

Mealy	Right End.
Leary	Right Tackle.
Brumbaugh (Captain)	Right Guard.
Soler	Centre.
Heubeck	Left Guard.
Carl	Left Tackle.
Hess	Left End.
Tauszky	Quarter Back.
Dawson	Right Half Back.
Robb	Left Half Back.
Bowes	Full Back.

Substitutes: Clemmitt, Mitchell, Jones, Mason, Montesinos.

The following is a summary of the games played:

Oct. 8, at Port Deposit; Polytechnic, 0, Tome Institute, 6.

Oct. 15, at College Park; Polytechnic, 6, Maryland Agricultural College 2nd, 0.

Oct. 29, at Ellicott City; Polytechnic, 11, Rock Hill College, 0.

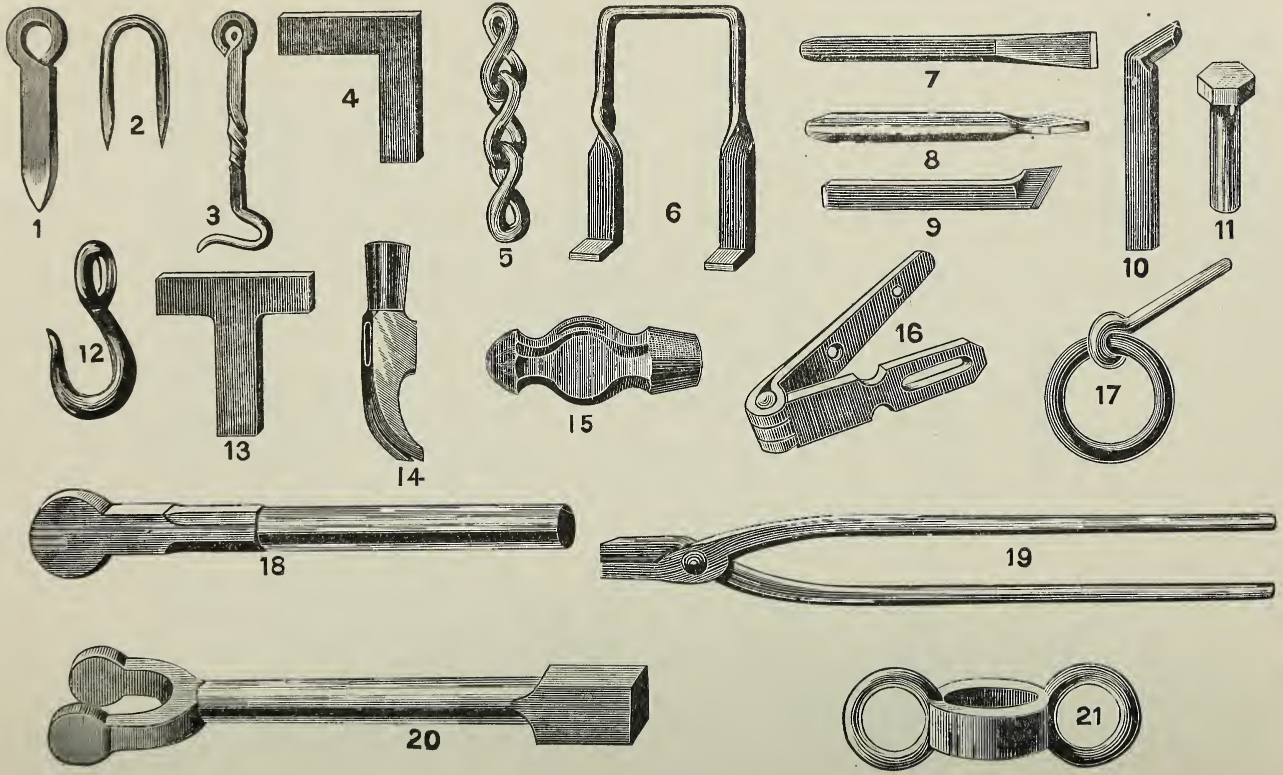
Nov. 2, at Annapolis; Polytechnic, 0, St. John's College 2nd, 12.

Nov. 9, at Oriole Park; Polytechnic, 6, Boys' Latin School, 0.

Nov. 15, at Walbrook; Polytechnic, 0, Baltimore City College, 6.

Nov. 22, at Druid Hill Park; Polytechnic, 6, J. H. U. Freshmen, 0.

Nov. 24, at Annapolis; Polytechnic, 6, Naval Academy Plebes, 16.



FORGE WORK.

Catalogue of Graduates.

CLASS OF '87.

Clarence G. Bouis,
George C. Bump,
Lucien Dallam,
Otto H. Ehlers,
Osma K. Gardner,
Herbert F. Gorgas,
Joseph Greenbaum,
Henry W. Hahn,
Minor F. Heiskell,
Robert Hooper,
William S. Hugg,
Thomas J. Irons,
Josph H. Kuehn.
P. Charles Nelson,
Flavius J. Pennington,
Richard Piez,
Henry M. Price.
Walter G. Rinicker,
William A. Robertson,
Albert Rosenberg,
James B. Scott,
Walter R. Sweeney,
James C. Thompson,
Adolphus Tiemeyer,
Frederick H. Wagner.

CLASS OF '88.

Arthur O. Babendrier,
Edward Binswanger,
Bernard H. Brooke,
Sydney S. Bouis,
Julius Fireman,
Thomas G. Ford,
George M. Gaither,
John H. Harvey,
Howard Harvey,
Walter J. Herrman,
Joseph H. Hooper,
John P. Jefferson,
William Johnston, Jr.
William Mencke,
William F. Mylander,
Edwin F. Orem,
Edward B. Passano,
George E. Repp,
Harry E. Roberts,
George C. Robinson,
Hanson Robinson,
Robert E. Rodgers,
George H. Sickel,
Washington B. Stanton,
Orlando C. Weeks.

CLASS OF '89.

William F. Ackerman,
Samuel R. Adams,
Morgan H. Baldwin,
Isaac Behrend,
Albert T. Barrett,
John L. Ehrman,
Allyn Field,
Harry M. Ford,

Louis H. Gerding,
Arthur Gordon,
Ernest Griffith,
John S. Hand,
Joseph Isaac,
Claiborne M. James,
Albert C. Layman,
Charles W. Leach,
J. W. C. Meikle,
Rozier L. Bouis,
Robert H. Buschman,
Charles C. Constantine,
Edward P. Cromwell,
Howard Crosby,
George W. Moog,
John K. Mount,
Robert W. Peach.
Charles E. Phelps, Jr.,
William G. Robertson,
Robert C. Round,
Myron S. Rose,
William C. Seigmund,
Joseph Steifel,
Harry P. Suman,
Carroll Thomas.

CLASS OF '90.

John F. Abendschein,
G. S. Barnes,
J. H. Bokee,
John E. Broadbelt,
W. H. Fahrinholt,
Chris. Feick,
J. Froelich,
William P. Gundry,
E. C. Harris,
J. C. Mattoon.
John D. Pugh,
A. O. Robertson,
William F. Schultz,
Michael D. Schaefer,
William P. Shriver,
Theodore Straus.

CLASS OF '91.

Walter Amos,
Basil Benson,
William Benson,
William Boucsein,
Morde Bren,
John J. Caine,
George Dannettel,
Charles Ehlers,
Ferdinand B. Keidel,
J. Edgar Knipp,
Samuel McNeal,
James C. Phillips,
Herbert M. Reese,
Edmund W. Robinson,
Reuben Row,
Warren S. Seipp,
Richard S. Warner,
William A. Young.

CLASS OF '92.

Edwin W. Antes,
John P. Baer,
Frank J. Borie,
B. Harrison Branch,
Leonard Burbank,
William C. Butler, Jr.,
J. W. Dawson, Jr.,
Royal R. Duncan.
Charles R. Durling,
Isidor Deutsche,
Walter H. Eisenbrandt,
William T. Holmes,

Frank B. Hooper,
Edgar N. King,
John Langford,
Louis Liepman,
R. M. Miller,
J. C. Miller,
Joseph Mullen,
William H. Rose,
Albert G. Singewald,
William H. Soine,
William E. Straus.

CLASS OF '93.

Theodore H. Ackerman,
Herbert Addison,
Oregon R. Benson,
Percy Thayer Blogg,
C. Raymond Carson,
William John Cochran,
E. C. D'Yarmett,
Henry M. Fitzhugh,
Clarence S. Hand,
James F. McShane,
Clarence F. Morfit,
F. H. Phelps,
Edwin Schenck,
John R. Uhler,
L. Ismay Van Horn,
Charles P. Weishampel,
R. L. Williams.

CLASS OF '94.

Edward H. Bell,
Albert E. Bowen,
J. Straith Briscoe,
Harry Cotton,
Carroll Edgar,
Frederick Kopp,
Philip Littig, Jr.,
Thomas Q. McGinn,
Herbert A. McGaw,
Horace J. Miller,
Louis Mueller,
George M. Parlett,
Charles Schlicker,
Alan P. Wilson,
John Zeubert,
Pliny Cutler Hall,
Edward J. Herring.

CLASS OF '95.

George W. Brown,
Clifton A. Coggins,
Harry W. Francis,
Graham B. Hall,
William W. Hogendorp,
Albert J. Hooper,
Frank A. Hornig,
Howard L. Hoskins,
Edward M. Likes,
Ward P. Littig,
Alfred F. Loeser,
Thomas J. H. Magness,
Herman F. Meyer,
George N. Rogers,
Hamilton D. Ruth,
Richard F. Weishampel,
Carl A. Witthaus.

CLASS OF '96.

Samuel Hosea Armstrong,
Howard Douglas Bennett,
James Gomelia Boss, Jr.,
William Augustine Boykin, Jr.,
Robert Lemmon Burwell,
Harry Parr Diggs,
Frederick L. H. Glendmeyer,
William Howard Hamilton,
Arthur Worthington Hawks, Jr.,
Frederick Worthington von Stein.
Louis Kemp Hennighausen,
Harry Louis Homer,
Ludford Cohoon Jones,
Leon Alvyn Kohn,
Erich Albert Loeser,
Henry Louis Mencken,
Harold Vincent Patterson,
Harry Clay Powell, Jr.,
Gilmor Meredith Ross,
Thomas Quincy Scott,
Henry Bonn Silverthorn,
William Henry Smith,
Roscoe Conkling Sweeny,
Charles Edwin Wilson,
Olin Alexander Wilson.

CLASS OF '97.

Louis Fabian Bachrach,
Alan Marion Bennett,
William Melvin Carter,
Elvin Griswold Cromwell,
John Towson Elsroad, Jr.,
John Montgomery Gambrill,
Ernest Cummins Hatch,
William Hain Kirwin,
Harry L. Kugler,
Chester Waters Larner,
Howard Osgood Preston,
George Gottlieb Schnepfe,
Frederick Lewis Schwartz,
Joseph Stewart Smith, Jr.,
Douglas Alan Sparks,
Joseph Morrison Sparks,
Wilson Ward.

CLASS OF '98.

Thomas Jefferson Andrews,
Alan Joseph Bachrach,
Leo Bauersfeld,
Wilbur McKnew Bosworth,
Frederick Derick Dollenberg, Jr.,
Romulus Griffith Doyle,
John Howard Flayhart,
Henry Galloway,
Charles Raymond Gantz,
Samuel Thomas Griffith,
Alfred Cummins Hatch,
William Herman Hubers, Jr.,
Joseph Lowrie Ingle, Jr.,
John Scott Longnecker,
John Walter McGreevy,
Edward Harris Mealy,
William Charles Metcalf,
John Floyd Miller,
William Eldred Nolan,
Gurdon Tyler Pollard,
Walter Percy Poole,
John Maurice Rehberger,
John McCullough Rife,
Harry Rufus Ruse,
Paul Edward Schaum,
John Henry Sirich, Jr.,
John Smith,
Herbert Turner Snyder,
George Creamer Wilcox.

CLASS OF '99.

Charles E. Allen,
William B. Boettinger,
Harrison Brent,
Hugh W. Brent,
Edward Goodnow Clayton,
Edward P. Cooke,
Charles C. Crockett,
William W. Cushing,
Arthur Councilman Davis,
Charles H. Demitz,
Roland S. Focke,
Harry B. French,
Robert B. Harper,
Charles W. Held,
Ira Johnson,
George A. Knapp,
Walter B. Lang,
Harry Lowenthal,
George P. McCeney,
William E. McCord,
Marion H. McCoy,
Charles E. Mencken,
Charles T. Owens,
Edw. L. Schaun,
Harold B. Vincent,
Joseph A. Ward,
Charles C. Lucke,
John N. McCleester,
Blakeley A. McDonnell,
Edwin G. O'Conner,
William Taylor Phipps,
Emanuel J. Sedlacek,
Frederick C. J. Sternat,
Joseph R. Walter,
William C. Whelan.

CLASS OF '00.

John Walter Fred. Blizard,
Roy Stevenson Houck,
Galt Fayette Parsons,
Samuel Moore Johnson,
Luther Chase Wright,
Walter Bowen Buttner,
Gustav Frederick Linck,
Horace Kirk Faust,
Thomas Osborn Wanseben,
Morgan Moore,
John Charles Masopust,
Walter Groverman,
Lawrence Gunton Allbutt.

CLASS OF '01.

Joseph M. Beehler,
C. Ernest Conway,
William M. Demitz,
Charles F. Goob,
Richard G. Harris,
Irving C. Hess,
Charles W. Hoppert,
Carlisle L. Hubbard,
Edward E. Johnston,
Thomas H. Kenney,
Charles E. Lane,
Andrew J. Lowndes,
Ross E. Lynch,
Allen L. Malone,
Richard E. Marston,
Harry Mehrling,
John A. Raidabaugh,
T. Warden Rinehart,
William B. Rosenthal,
Edward Samuel,
John C. Siegle,
Walter H. Tapman,
Sidney C. Vincent,
George P. von Eiff,
Ernest B. Walton,
Arthur S. Weiss,
George K. Yost,
Philip H. Zipp.

POSTGRADUATE CLASS OF '02.

(Four Year Course.)

Joseph M. Beehler,
C. Ernest Conway,
Irving C. Hess,
Andrew J. Lowndes,
Allen L. Malone,
John A. Raidabaugh,
Sidney C. Vincent,
George P. von Eiff,
Philip H. Zipp.

CLASS OF '02.

Joseph A. Baldwin,
Frank O. Boyd,
John B. Cautley,
Robert Dall,
William L. De Baufre,
John K. Flickenschildt,
Walter M. Gieske,
Donald S. Hays,
Joseph T. Henthorn,
John S. Hess,
I. Seeley Jones,
D. Frank Lamble,
LeRoy M. Langrall,
H. Quimby Layman,
John G. M. Leisenring,
William N. Michael,
Charles A. Pettit,
William S. Samuel,
G. Forney Shryock,
Charles F. Yardley.

POST-GRADUATE CLASS OF '03.

(Four Year Course.)

John B. Cautley,
Robert Dall,
William L. De Baufre,
John K. Flickenschildt,
Walter M. Gieske,
Donald S. Hays,
John S. Hess,
I. Seeley Jones,
LeRoy M. Langrall,
H. Quimby Layman.

Specials { Arthur C. Davis,
Charles A. Pettit.

CLASS OF '03.

Elmer Armiger,
Paul Backhaus,
Oscar F. Benjamin,
Owen C. Blades,
Harry N. Brannan,
Frank B. Burton,
William N. Crisp,
John W. Dorsey, Jr.,
Christopher J. Frank,
Milton H. Gross,
Edward Hering,
Charles E. Herth,
James B. Jones,
Milton Kraemer,
Herman Lucke, Jr.,
Edmund C. Lynch,
Arthur B. Marston,
Harry M. Mason, Jr.,
Sidney Newhoff,
Manley P. Northam,

Harold M. Parsons,
Ernest M. Poole,
J. McDonnell Reid,
Martin J. Reynolds,
August H. Schaaf,
Howard I. Schulz,
George F. W. Sims,
Wilmer T. Stone.

POSTGRADUATE CLASS OF '04.

(Four Year Course.)

Paul W. Backhaus,
Harry N. Brannan,
William N. Crisp,
Edward Hering,
James B. Jones,
Milton Kraemer,
Harry M. Mason, Jr.,
J. McDonnell Reid,
Martin J. Reynolds,
George F. W. Sims.

Specials
Frank B. Burton,
H. Milton Gross,
August H. Schaaf.

CLASS OF '04.

Chester A. A. Albrecht,
James B. Arthur,
Marion V. Bailliere,
Joseph Bowes, Jr.,
Andrew K. Brumbaugh,
Clarence C. Clickner,
Edward C. Cromwell,
Frederick L. Dixon,
Charles A. Edel,
Frank P. Fifer,
Emanuel Fritz,
George Gittelsohn,
J. Lyell Gressitt,
Edward J. Hecker,
John H. Hills,
Harry J. Hodes,
Benjamin F. Hoffacker,
Harry V. D. Hunt,
William C. Hurley,
Charles A. Langrall,
Herman W. Lasser,
Daniel J. Leary,
Leon Marmor,
Samuel May,
John L. Mosher,
Charles P. Niederhauser,
Robert G. Pangborn,
Massimo Pisani, Jr.,
George S. Robertson,
George M. G. Schaefer,
Leon Small,
Oscar E. Smith,
Marion Steinberger,
Harry D Thurlow,
Harry Waldorf,
Charles W. Whittle,
Edwin L. Willson,
Louis A. Witte,
William P. Wittmer,
Alexander H. Woolen,

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